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Willard Straight Hall, the union building and headquarters for the convention.

Willard Straight Hall, the union building and headquarters for the convention.

THE ANNUAL CONVENTION AT CORNELL UNIVERSITY, ITHACA, NEW YORK

By DEXTER S. KIMBALL

Dean, College of Engineering

The members of the Faculty of the College of Engineering of Cornell University are looking forward with anticipation to entertaining the Society next June and a word as to the plans so far developed may be of interest. Since the Society convened at Cornell ten years ago additions to the physical equipment of the University have greatly extended the facilities for entertaining the Society and every effort will be made to make all who attend comfortable.

Headquarters and registration will be in Willard Straight Hall, the student union building recently erected. This building contains large lounging rooms for both men and women, a reading library, game room, barber shop and other facilities. It also contains a large cafeteria, with soda bar, a tea room and restaurant with table service. There are also a number of private dining rooms which are available for small dinners, etc. Since this building is within a few minutes walk of all residential halls, all guests will be fed at Willard Straight Hall, and the dining rooms of the residential halls will not be used. It is believed that this will be more satisfactory for most people and probably less expensive. It will tend, also, to closer personal contacts as all will be gathered three times a day in one building with ample room for social contacts.

Guests will be housed in the residential halls for women as these are better equipped, so far as ladies are concerned, than men's dormitories. Balch Hall, a new building, consists of four units each housing 75 persons and each equipped with large and beautifully furnished parlor and lounging rooms, baths, etc. This new hall is just across the street from Prudence Risley Hall in which most of the guests were housed in 1923. This hall is also splendidly appointed with lounging rooms and baths. Assignments will be made to these halls first and if they will not accommodate all who come, use will be made of the Sage residential hall, an older but very comfortable building. It will help greatly to make satisfactory assignments if notice of intention to attend is sent in promptly.

Balch Hall, women's residential hall which will be used to house guests.

Balch Hall, women's residential hall which will be used to house guests.

Prudence Risley women's residential hall which will be used to house guests.

The Cornell Commencement is held on Monday, June 18th, and the residential halls will not be available therefore until Tuesday, June 19th. The rooms may be occupied until Monday, June 25th. The rates for rooms in the residential halls will be $2.00 for one night, $4.00 for two nights, $5.00 for three nights, $6.00 for four nights, $7.00 for five nights and $8.00 for six nights.

The rates at the Ithaca Hotel, European plan, are room with running water, for one person $2.00, for two persons $4.00; room with bath for one person $3.00, for two persons $5.00 to $6.00.

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FIVE-YEAR ENGINEERING COURSE*

By W. S. RODMAN

Dean of Engineering, University of Virginia

The subject announced for this address should be regarded as symbolic rather than as specific, as I hold no particular brief for the five-year engineering course except in its implications as offering an undoubtedly better program for preparation for a life-work in the professional engineering field than any shorter course such as the so-called "norm" of four years. A better title might well have been "The X-Year Engineering Course," where X is greater than four, and may eventually prove to be five, six, seven or even eight.

In order that there may be no misunderstanding with regard to the type of course with which this presentation is to deal, it should be stated at the outset that at present I am concerned only with those curricula which are somewhat loosely termed as professional in contradistinction to the many programs of great significance in engineering education, properly designed to furnish instruction and training to considerable numbers of future artizans, foremen, technicians and the like; or, if you please, this discussion has reference to the problem of adequate preparation for those who may aspire to become leaders and officials in the life of our nation rather than that affecting much larger numbers of an essential rank and file preparing for rather permanent subordinate positions in industry and engineering enterprises.

It must be further understood that the course in question should start with properly prepared students taken directly from preparatory schools at graduation and should continue for a period sufficiently long to insure the integrity of the product and its adequate preparation for the tasks to be undertaken. It is equally important to state also that this course is not intended to overlap nor lessen the necessity for post-graduate work arranged to perfect in specialized fields.

It is quite superfluous to state that this question of a longer curriculum is no new one, but has been argued and debated at intervals for a number of years. Reference to a Report made in June, 1927, by the Board of Investigation and Coordination of the

* Presented before the Engineering Section of the Convention of the Association of Land-Grant Colleges and Universities in Chicago, November 13, 1933.

Society for the Promotion of Engineering Education, after a most complete study extending over five years, will disclose a particularly good discussion of the question of a longer curriculum. The findings reported were in favor of a continuance of the "normal" four-year curricula.

I venture to question and challenge the complete validity of that conclusion in the light of the present and probable future conditions even though such questioning may appear presumptuous in view of the recognized calibre and ability of those responsible for or subscribing to the findings as reported.

In connection with an earlier preliminary Report in November, 1926, the same Board summarized the essential features of a program designed to prepare for the professional engineering field as follows:

"*a.* An introduction to mathematics and the physical sciences with reference to engineering needs and taught in connection with concrete applications;
b. An introduction to the forms of language, verbal, graphic and symbolic, which are used for the communication of facts and ideas in the realm of engineering;
c. An introduction to the social sciences, particularly economics, as related to engineering activity;
d. Appropriate elements of liberal culture;
e. An effective try-out of engineering aptitude and interest and an inculcation of engineering methods and points of view."

I heartily subscribe to this program, provided each of the several elements be developed to the proper and necessary degree. At the same time I very seriously doubt the possibility of covering the program adequately in the present "normal" four-year curriculum, and I am certain that this opinion is shared by a considerable number of persons interested in this field of education, hence my presence here to set before you in general terms some of the reasons which are deemed pertinent to the support of a longer curriculum as a new "norm."

In the same Report appears a summary of basic purposes for which an engineering course should fit the student for his future activities as follows:

"1. The control and utilization of the forces, materials and energy of nature;
2. The organization of human effort for these purposes; and
3. The estimation of costs and appraisal of values, both economic and social, involved in these activities."

One may accept readily this outline, provided once more that each element be given the necessary breadth of content. I would favor adding a fourth category to the three just mentioned if engineering education is to provide adequately for the normal needs of its students. We owe to these men whatever may be given to them to serve them not only in their general technical field, but in the equally important field of good citizenship, including a helpful background on which they may develop in a worthwhile way the greater amount of leisure which seems inevitably about to become a part of life for most individuals in the future. Looked at from this broader viewpoint again I question the real adequacy of a four-year course and thus turn to a necessarily longer program.

It is quite evident that an undercurrent of feeling has developed in a number of groups in the past years which has sought expression in several sporadic attempts to incorporate, by one method or another, a system by which the effective curriculum in engineering would be lengthened to five or six years. It is of course well known that these attempts have not proved particularly successful and in consequence of this non-success the conclusion has been drawn that the lengthened curriculum is inherently impracticable. However, considering the conditions under which the attempts have been made, it would have been surprising had they shown any considerable measure either of popularity or promise. Yet the lack of success furnishes no real proof that the longer curriculum is lacking in essential virtues or indeed would not be truly superior to the accepted "norm."

No major advance in an educational program is liable to attain a large measure of acceptance until its tenets are embraced by most of the institutions offering instruction in a particular field as well as enjoying the concerted support and encouragement of those extra-institutional agencies whose personnel is largely drawn from the student bodies undertaking the particular program of instruction.

There has never yet been anything in the nature of a concerted action toward the longer curriculum in engineering by engineering college faculties, although a near approach to such action was attempted by a group of some fourteen mid-western institutions about 1922. This attempt proved abortive largely because at about that time was started the very thorough study of engineering education by the Society for the Promotion of Engineering Education which produced the reports from which quotations have already been made, showing support of a *status quo* so far as the length of undergraduate curricula was concerned, and thus the movement by the mid-western group did not survive the blow dealt it by the Report.

Probably the major reason for the failure of the longer curriculum to become more widely established is found in the lack of anything approaching a concerted approval of or demand for such a program by the engineering fraternity at large. For many years now there have been in active operation a number of engineering organizations of national extent, which have largely gone their several ways with almost complete absence of cooperative activities in any line of endeavor, educational or otherwise. This failure on the part of engineers in general is largely the cause of most of the conditions which engineers themselves regard as unsatisfactory, such as failure of the engineer to receive the recognition or prestige which are so often accorded the professional groups in theology, law and medicine. These latter groups are so nationally organized that they may act as units and thus have been able to fix educational standards, protect the professional status and insure due recognition from the public, aided, of course, by the very important fact that the public is always in much closer personal relations with the individual members of these professions than can ever be expected with relation to engineers.

It seems essential that engineering as a profession can only hope to reach its deserved status by a more inclusive and cooperative activity along many lines by engineers of the several specialities, and happily there are recent indications as well as movements which hold out real hopes of such action in the immediate future.

Let us examine some of the stated attitudes with regard to this question of a lengthened curriculum together with certain suggestions for a possibly corrective program which would more nearly meet the very evident demands for a better balanced preparation for the class of students under consideration.

In the report already quoted may be found the statement that for eighty years the four-year undergraduate curriculum has served with a high degree of satisfaction in supplying new personnel for engineering activities. In view of the phenomenal expansion of engineering applications, widely increased basic foundations in the physical sciences, and more recently a very proper insistence upon a more complete treatment of economic and social features, is it unreasonable to feel that the four-year curriculum can no longer be regarded as an adequate program for satisfactory preparation for service in its broadest implications? I insist that it is not unreasonable to so assert.

Some authorities state that the undergraduate engineering curriculum should be regarded as offering an election of courses with the usual undergraduate courses in arts and sciences as the alternative. That, therefore, the lengths of the curricula must be the same, four years, else the majority of incoming students will

choose the four-year liberal arts course in preference to a longer program in engineering. I cannot force myself to take this argument very seriously in view of the decidedly different goals attained by the students at the end of the respective curricula. I feel that the student completing the engineering course should be so much better prepared for a life of service than one at the completion of the liberal arts course that there is no valid comparison between them, and that the extra time and expense involved in the longer course would be demonstrably well spent.

In a study of engineering curricula over a long period of years for the purpose of comparing the earlier requirements with those of present-day programs, the statement was made by the author of the study that students in general demand some sort of handle in the way of a degree at the end of four years of college grade work. I cannot agree with this broad statement. There appears to be no dearth of students starting and finishing courses in law, medicine and theology which require spending from five to eight years following preparatory schools, before graduation. They do so because it is recognized that only by such time spent may the student obtain his degree from an approved, reputable institution. When the engineering profession sees fit to sanction some longer course than four years as the approved preparation for entering actively the field of engineering, there will be no hesitancy on the part of really interested students in complying with the demands of a lengthened curriculum.

Some advocates for the retention of the four-year program advance the argument that a longer engineering curriculum would probably result in shifting students to the four-year arts course who now take up the four-year engineering program. Granted that such would be the case. Such a result need not occasion too much concern lest the engineering matriculation might unduly drop away. It is rather evident that now all too many students enter engineering who should never have attempted its rigid disciplines, as attested by the heavy mortality between entrance and graduation. Should a considerable proportion of this class of students be diverted at the start it might well result in a very real benefit to the engineering schools by reducing the mortality without at the same time reducing in anything like the same measure the numbers surviving for graduation.

These same advocates stress the necessity for a program of such length that those completing it shall be about twenty-two years of age when they enter their life work. An added year or two would make these men so much more capable for service that, particularly in the radically changed conditions which seem to confront us for the future, those added years would be most desirable.

That there is a considerable body of thought which recognizes deficiencies in the present curricular set-up is evidenced in a variety of ways.

Certainly those institutions which have already made attempts to meet more nearly the demands as they see them by setting up combined arts and engineering courses on the divided system, fairly comparable with the existing pre-legal and pre-medical plan which uses the arts college for certain fundamental work on which to superimpose an intensive legal or medical curriculum, have been motivated by a belief in the inadequacy of older plans. However, the unified course with an entire program supervized by the engineering faculty seems much better suited for the solution of the problem.

Many realizing the deficiencies in former curricula with respect to economic questions have suggested that the essential viewpoints might well be given by the several technical instructors as a part of their routine courses. This method does not appear to offer a really happy solution of the problem for several reasons. For one thing the arrangement does not appear basically sound. If it be expected that proper economic teachings are to be procured by relying on a considerable number of individuals, the most probable result will be in accord with the old adage, "Too many cooks spoil the broth." A task supposedly cared for by many will result in definitely poorer results than if it be cared for by a designated staff whose major duty should be to care for those aspects of economic bearings which are deemed essential. Another inherent weakness in this diffused presentation would seem to arise when one considers that at present the time actually available for covering properly essential technical features is usually all too short, and any expectation that both a proper technical and economic treatment may be secured in the limited time now available is bound to be largely disappointed.

In this category might be placed a recent suggestion that upon the individual staff members in their regular courses there should be placed the duty of emphasizing regularly the importance of the varied duties of citizenship which the engineer of the future must more assiduously practice. Theoretically this suggestion sounds well but in practice its efficacy or suitability seems widely open to question.

A prominent practicing engineer, whose statements show without any doubt whatever in his opinion more time must be devoted to preparation, offers the suggestion that the students devote more time in each school year thus providing for a lengthened curriculum without involving an increase in calendar time. Such a program would, of course, make available about an additional

year devoted to studies in a four-year calendar program by reducing the so-called abnormally long summer vacation. Some students pursue this program at present but as a desirable solution of the difficulty it does not, I think, merit any great amount of consideration. It would seem more desirable to utilize the normal vacation periods now available for activities offering some relief from the rigid disciplines of the class-room, certainly for the main body of normal students. Youth deserves some play time, some surcease from the ordered program, and might better be guided to use these periods for travel, recreation, industrial experience or such other activities as are capable of producing a well-rounded individual, rather than being required or advised to shorten his calendar curriculum by such intensive application to formal studies.

One might continue with illustrative material indicating in various ways that the subject of an optimum educational program for engineers is engaging the attention of considerable numbers. This is a favorable situation and lends hope that it may mean a gradual focusing of attention of even larger and more diverse groups upon this fundamentally important problem. Little real progress towards the best solution can be hoped for until it reaches the consciousness of every representative group concerned with the program.

My contention is that, since the extended study by the S. P. E. E. Board and its Report in 1927, so many conditions have already changed and such a different future outlook appears before us, it will be the part of wisdom to reopen the study, reexamine the evidence both old and new, and try to arrive at a new decision which may prove acceptable to a majority of the profession.

That this matter is to engage the attention of many in the immediate future is attested by the fact that at a conference of administrative officers of engineering colleges held at Madison, Wisconsin, during the first week of July last, a resolution was adopted requesting the governing board of the S. P. E. E. to set up an appropriate and representative committee to study this curriculum-length problem and to report next June at the annual meeting. What will come from this study remains for the future to disclose, but whatever results it should serve to give a more valid solution and recommendation than the report of six years ago. New evidence is available and as in courts of law it behooves us to reopen the case and reconsider the earlier verdict.

There is one other consideration which I cannot forego mentioning briefly and that is the matter of the symbol marking the completion of an engineering course, namely the degree. The present situation, which shows that for comparable courses there

may be awarded an amazing variety of degree appellations ranging from an A.B., through a whole family of Bachelors of Science with or without more descriptive tags, to a professional degree such as C.E., M.E., etc., seems to be quite indefensible, but most difficult to correct.

Engineering education should adopt some appropriate degree symbol which will convey to the public something at least approaching the definiteness of the M.D. in Medicine and the LL.B. in Law. Personally I feel that the various B.S. combinations have been severely overworked and perhaps a straight Bachelor of Engineering or Bachelor of some major in Engineering should be adopted as the first degree. This matter is intimately tied in with studies of any engineering curriculum whether it is to remain in a four-year or advance to a longer program. It is to be hoped that this matter may receive the attention which it deserves and that some logical and consistent symbol may be chosen and adopted.

I stated earlier that recently the signs and movements for a more coöperative activity of all engineering agencies in the solution of mutually important problems were happily evident. I refer particularly to such organized bodies as Engineering Foundation, American Engineering Council, and most recently the newly setup Engineers' Council for Professional Development, whose task it is to study and recommend practices and procedures affecting engineers one might almost say from the cradle to the grave. This Council has already organized able committees and represents the most heartening coöperative attack by the National Engineering Societies, the S. P. E. E. and the body of State Engineering Examining Boards which has yet been attempted. Much of good is to be expected eventually from this activity.

Since one major problem to be attacked by this new Council concerns itself with engineering schools and their curricula, it is especially timely that the question of the longer curriculum be brought to such a solution as may properly be incorporated in the recommendations which will issue from the Council sometime in the not too distant future.

My purpose will have been accomplished if my discussion here before you shall occasion in your institutional staffs thoughtful consideration of the situation and a will to coöperate with all legitimate agencies which have the burden upon them of determining the trend of engineering education for the next few generations.

SHOULD OUR ENGINEERING CURRICULA BE CHANGED IN THE LIGHT OF THE PRESENT ECONOMIC SITUATION? *

By A. N. TOPPING,

Professor of Electrical Engineering, Purdue University

Whether the change suggested in the title should be made may be debatable, but there is no question concerning the desirability of examining our curricula at intervals to ascertain if they are producing results fairly well agreed upon.

In considering this matter shall we conclude that something is wrong with the curriculum, or its administration, because only about 35 of every 100 men entering as freshmen finally graduate? This has been suggested in certain academic quarters and the view seems to be held by at least one well known college president who refers to those, who for one reason or another, do not graduate, as "human wreckage" outside the university doors.

With this view I prefer to disagree, for as I see it, the principal advancement of the human race has come through intellectual effort to attain some desired end. And whether the end has been actually attained or not, the benefit to the individual and to the race has been very real regardless of the ability of the individual making the effort. The sixty-five who did not remain four years doubtless profited in proportion to the effort and time spent, and society to that extent was benefited. It appears that we need to look beyond that superficial criterion.

It will likely be agreed that engineering education should:

1. Make the individual useful to society.

2. Enlarge his possibilities for satisfaction with life and enjoyment of his environment.

3. Specifically make it possible that his usefulness to society and some of his activities should lie within the field ordinarily known as engineering.

It may then be inquired whether our curricula and teaching have done these things in the past. Somewhat imperfectly it seems, to me. By this I mean that among those who enroll, and pursue, with greater or less energy, an engineering course of study, there are many whose purpose is only to escape honest labor until

* Presented at the November, 1933, meeting of the Purdue Branch, S. P. E. E.

such time as graduation may ease them into white collar jobs. So long as a large number of persons attend college and pursue engineering courses for no higher purpose than to get a degree in order to get a job, it is doubtful if society is well served, and it is doubtful that many are thus enabled to enjoy the durable satisfactions of life. Too many attain the viewpoint of the President of the Clothespin Manufacturers Association who proposes to propagandize the United States to induce parents to produce more babies because this would seem to be a sure way to increase the demand for, and consumption of, clothespins. But is this attitude and viewpoint of the student the fault of the curriculum? Probably not. Or of our teaching? Perhaps.

It may be pertinent to inquire whether the present economic situation indicates that the ideals and purposes of engineering education should be changed, or that our method of achieving those ends need be different? I venture to say that it is difficult to see wherein conditions are essentially different from what they were four years ago, except in degree. Probably the requirements for a successful engineer are not different now from what they were at that time. The lack of them is only more obvious.

Society's and industry's need is now certainly, for men capable of independent thinking, of sympathetic interests, and broad vision which should include, not only an appreciation of the human aspects and relations in technical and industrial matters, but also of the broader economic relations between masses of human beings as consumers of industrial products and masses of human beings as producers of those products.

Need for such men in influential places is now no greater than heretofore. The need is now *only more obvious*. Indeed it is conceivable that with a larger number of such men in political life and in charge of industrial affairs the present sorry state of matters might not now exist.

If the foregoing may be regarded as approximately correct and if it shall be conceded that engineering schools have failed in the past to produce in sufficient numbers men of qualification approximating those described, the question then is what can be done about it.

1. Can a modification of the curriculum be made which would improve the situation?

2. May it be possible that a modification of the administration of the curriculum or of our methods of teaching would bring us nearer to the desired results?

It will of course be pointed out in defense of present engineering education and methods that men of high qualifications, previously specified, are born, not made, and to a certain extent this

is true, but it is also true that the engineering instinct, breadth of vision and sympathetic viewpoint lying dormant, or in embryonic state, in most individuals can be awakened and developed by suitable environment and contacts such as engineering schools presumably provide.

Of course there is an extremely wide range between the capabilities of the best and poorest of these individuals but it may be doubted that as an engineering institution, or as individuals, we are doing all that can be done to develop those latent capabilities.

As to curriculum the tendency is to push into it increasing numbers of courses in economics and the humanities, but the advisability of this is questionable. A consideration of the curriculum of the Electrical Engineering School at Purdue shows of 150 semester hours required for graduation only 32, or 21 per cent, are of electrical subjects. If we should deduct 12 other hours of shop and drawing there still remain 106 hours of history, language, English, mathematics, physics, chemistry, economics, etc., of which our liberal arts courses are comprised. The degree in a liberal arts course requires about 120 hours which it may be noted is only one semester more of this kind of study than the engineering graduate is required to take.

In effect then the engineering graduate has the practical equivalent of a liberal arts course plus the technical work. From this it would seem that, so far as curriculum is concerned, the charge of narrowness can hardly be sustained. The same situation doubtless exists in all of our engineering schools at Purdue and at most other institutions.

Of course it is quite possible that minor changes within the curriculum of the school may be desirable. For instance, a course in developing a winning personality, or a course teaching the technique of job getting and holding might seem to be most appropriate additions to make to the curriculum at this time. What to omit may seem less important. But after all, it will probably be agreed that the content of the curriculum is a very minor factor in the quality of men who graduate from Purdue and other engineering schools.

If the engineering curricula are not at fault, can it be that our procedure in more general matters may be unwise? I think so. Before breadth of vision with wide interests, and habits of clear independent thinking, so much needed in our industrial, economic and social life can be developed, much educational tradition and childish viewpoint, carried over from primary and secondary school days by our entering students, must be swept away or changed.

Under our present system of grading and graduating those traditions and viewpoints are continued, and the student, I believe,

suffers a handicap in his process of development toward the goal of real scholarship which we hope for him. The eagerness with which students count up their grades and look forward to graduation as the ultimate goal of their efforts is truly pathetic. The grade made in a course, the award of a distinction, the diploma or the degree at graduation, are, of course, only the externals, the seeming recognition by others, of presumed achievement. These things in themselves are not vicious. The tragic part of the process lies in the mistaken acceptance by the student of the symbol, the external, and in so far as he himself is concerned, the meaningless thing, for that deeply personal change that takes place within one in the educational process. The glare of the grade, the brilliance of the distinction and the degree blind him to the real purpose for which he is spending the good years of his life. And so he is content with the instructor's and the university's superficial measure of him as a substitute for real achievement. Of the possibility of real intellectual development of himself through self effort, he may never become conscious throughout his stay in the university. He acquires the habit of valuing himself and his achievements through the eyes of others instead of as he truly is.

Could anything be a greater obstacle to the development of clear thinking habits and a recognition of true values than such an attitude or state of mind? And the university, while deprecating this viewpoint and perhaps verbally combating it, actually, though unconsciously, encourages it by the very devices which it employs in the hope of stimulating scholarship and high ideals, namely, grades, distinctions, degrees, etc. If these were abandoned, I believe the misconception held by some, perhaps many students, that graduation implies an assurance by the university of a happy and successful life afterward would not be so prevalent. It seems unlikely, too, that any one afterward would refer to his college life as "$5,000 and four years of sacrifice gone for nothing." Perhaps there would be no after-graduation disillusionment with its bitterness and disappointment.

I venture the opinion that every teacher hopes to teach sometime a class in which grades and credit, other than self credit, is absent from the mind of a student, and in which interest in the subject is the only motive for the presence of the student.

I propose that we cease to grade students, or to classify our curricula by years, so many and such subjects for each semester of the freshman year and so many for each succeeding semester until the student has finished eight semesters. Instead let us fix no quitting point, *i.e.*, graduation for any student, but let him continue to study so long as it appears to him and the university profitable and desirable for him to do so, and let him cease his uni-

versity effort as soon as it appears that it is no longer possible or profitable for him to continue. Then he may withdraw without stigma, or the feeling of defeat and inferiority which I believe is fostered by the *present* system of graduation at the end of four years. "Human pride keeps more men in school than does common sense," is the way one student expressed it.

To me it seems that the present system of artificial and traditional time limits exerts a deadening influence, and makes of the students effort, scholarship, and attainment a more or less perfunctory matter instead of the vital, living, growing, personal thing the educational process should be.

With this educational bundle of hay removed from the view of the scholastic donkey, his efforts might then be directed toward the real purpose of intellectual and character growth and the lazy and unfit student would very soon be eliminated by natural processes. Moreover, since no motive for scholastic dishonesty would exist, intellectual honesty, that important attribute and necessary quality of every successful engineer, would be encouraged.

It is not expected that such a seemingly revolutionary step could be taken at once, or without encountering ridicule and very great opposition from many sources. From many students and parents would come the pathetic, protesting inquiry, "If no credits or degrees were given, of what use would it be to attend college?" As one student, commenting upon the proposal expressed it, "There wouldn't be anything left." Does not the expression just quoted justify the foregoing criticisms of our grading and credit systems and would it not be appropriate to reply to such a one, "There would still remain dancing and football"?

It is not at all certain that all teachers would agree that the results sought, while desirable, would by this means be attainable or if attainable to a degree, would not be attended with certain difficulties to an extent compensating any resulting advantage. University authorities and administrators would be quick to see a probable effect upon attendance and income and, while doubtless agreeing with its ideals and aims, would perhaps consider the proposal impractical on that account. Nevertheless, if we could only find our way to this point through the jungles of educational expediency we should have taken a long step toward our goal of producing more men capable of independent thinking and possessing a fine true sense of values wherever found.

Now what of our individual teaching in stimulating independent thinking and in encouraging broad vision and tolerant viewpoints. My own thoughts have been so admirably expressed by two writers in recent issues of the *Journal of Engineering Education*

that I venture to quote them as a fitting end to this paper. To quote Mr. Hirschfeld of the Detroit Edison Company, "What a man studies is in one sense of the least importance. How he studies is of the greatest importance. And, in the long run, how he studies is determined by how he is taught . . . teaching, for the purpose under discussion, should be directed primarily to the cultivation of the ability to think independently. . . . Speaking as a practical minded employer of engineering graduates, I find all too many who can solve problems only to the extent to which they can fit the conditions into some formula learned in college. Put them up against something that is not amenable to such treatment, and they are lost. Why? Because they do not know the ways in which such formulas are produced. Because they have been taught a collection of facts rather than the thinking process by which such facts and others, can be deduced from certain general concepts."

From Dean Holbrook in a recent address before the S. P. E. E. I quote, for its peculiar appropriateness at this time, some words relating to numbers of young unemployed engineers with whom he has come in contact in recent months, "They are without jobs; some are without money; most of them are discouraged and puzzled; some are frankly bitter. I should judge some of them to be misfits in the profession they think they have learned. In reviewing the procession my conclusion is that not only has industry failed in providing them with jobs but that you and I have failed in teaching them. We have given them a stone of technical details, when what they cry for is the bread of hope, of sympathy, of understanding. They want a philosophy by which to meet the realities of life. They have not found it in their textbooks . . . or in their college activities. My guess is that some of them will never find it. . . . Let's not confine the teacher-student personal relations to the necessary facts of the course. . . . Let's try to make him see the world as it is, in teaching him that it's a world of people as well as of things."

In concluding I should say that to me it appears that to adjust our work to the present situation, curriculum changes are far less important than a close examination by teachers of their own aims and teaching, and a study by college faculties and authorities of the effect of certain traditional educational paraphernalia upon the ideals and activities of its students.

PREPARATION OF THE ENGINEER FOR A PLACE IN ORGANIZED SOCIETY *

By ERNEST E. HOWARD

Consulting Engineer, Kansas City, Mo.

In the last decade or two we have read, we have heard, perhaps some of us have spoken, a great deal about this being the age of the machine, the age of engineering. Such declarations, of course, stir in the hearts of engineers a pride in the accomplishments of their profession, a certain ill-concealed sense of superiority, a feeling that they with their fellows do play and are destined to play a large part in guiding and directing life and destiny.

I recall with some embarrassment an address I made at one of our universities some dozen years back on "The Problems Created by the Engineer" developing the thesis that the problems, already beginning to be apparent, that the machine or engineering age was injecting into the scheme of living, having been produced by the engineers, could best be solved by engineers. Of that I am not now nearly so confident, for even if they had the chance I question whether engineers could wisely be entrusted with the task, and I feel sure society is not yet ready so to entrust them.

The recent furor of the Technocrats, promoted by sensation-seeking reporters, resulting in a few startling and faulty declarations based on undigested data, soon was swept from the news columns and from people's consciousness by the latest divorce and marriage of a popular screen actress or the latest kidnapping. What few facts were behind the extravagant statements were fairly well known to engineers even though novel to many newspaper readers.

Most ridiculous were the bland assumptions that the great mass of the public wanted their lives directed by a few self-elected Technocrats, and that the Technocrats were possessed of the wisdom to manage and direct the marvelously intricate machinery of business and industry with the endless factors of personality, preference and prejudice. It soon developed that the Technocrats were not able to keep their own petty affairs running smoothly. Many engineers are carrying on in the great experiment of nation-wide control and direction of industry and of business undertaken

* Presented at the October, 1933, meeting of the Kansas-Nebraska Section, S. P. E. E.

by our great President, but it is not evident that Technocrats have been called upon for leadership.

For while this may rightly be called the engineering age it cannot rightly be called the engineers' age. It is my impression that society on the whole respects the engineer's ability, is ready to take advantage of it, wants the results, but beyond that regards the engineer as rather out of touch with the problems of everyday life. Of course there are some, I think there are many and increasingly brilliant exceptions. But I ask you to consider the average engineer as you know him in your community life.

You who have these endless processions of students forever marching through your lecture halls and laboratories, disappearing to make way for new recruits coming like fresh armies, would, I believe, say that few engineering students are the chosen leaders in the general and communal activities of college, few perhaps have much sympathy or patience with the common interests of the majority. Relatively as few engineers are sought for leadership in their community life.

My question then is, what place in organized society does the average product of our engineering colleges command, and how can engineers be prepared for different or more important participation in human life, assuming that to be desirable.

You will note I am a bit cautious. I think it is generally agreed that in his own field the engineer has reached a high degree of accomplishment, much higher than has been arrived at in many other phases of our life. For instance, many lawyers will agree that it is a question whether the law has developed so as to provide greater or less justice than formerly. We are amazed at the opposed views of economists and the excuse that they deal with no exact science. Much of engineering is not exact science and has been developed by experiments on small parts and not on whole mechanism, with possibility of destruction of the whole. But if it should be desirable that engineers should undertake other than the purely engineering problems of organized society, they should have adequate preparation—preparation of a sort the average engineer does not now have.

Not long ago I sat in a group of men where some one made reference to this being the engineers' age. One of the men who had spent a life time as an investment banker—promoting banker might be a better term—made light of the engineer in business life. "An engineer never gets anywhere with his plans," he said, "without running to a banker. The banker is the man who takes the responsibility of going forward with a project or mechanism." "I call on engineers for technical skill in their lines," he continued, "as I call on expert accountants for technical skill in theirs,

but I don't want their business ideas." "Moreover," he added, "I have known of very few enterprises initiated by engineers; usually there is some non-technical promoter who starts with an idea and calls the engineer in to develop it."

The Governor of a nearby State recently consulted a friend of mine concerning the personnel of a Commission to be appointed. My friend suggested a man able and favorably known. "Why," said the Governor, "that man is an engineer. This is a job for a business man who knows how to meet and deal with the public. An engineer would ruin me in such a position."

Perhaps most of you will agree with me that the Governor's attitude seems biased and doubtless based on some unfortunate experience. But I must reluctantly confess that these two incidents characterize the attitude of many business men and even men of other professions toward professional engineers.

You will note this distinction—when engineers become more identified as contractors, or as buyers and sellers of engineering products, the feeling that the engineer cannot have a sympathetic understanding of the problems of business or of the ordinary affairs of human life, seems to disappear, or at least to be lessened.

The peripatetic character of much engineering employment, the temporary tenure of residence and many other elements of an engineer's life might be cited to explain why he is so rarely chosen by the people as their representative, or to serve on administrative boards, so infrequently turned to as the outstanding citizen to guide and direct social efforts. But I incline to the belief there are reasons more fundamental.

The young man inclined to engineering work is very prone to think his education should be purely technical, that the study of cultural subjects is of no advantage—or, as I heard a high school student, from an intelligent family, express it, "The Study of English and History won't get me anything in Engineering." But this question has been much discussed and I understand among present-day educators there is a very broad appreciation of the value of cultural studies, of the humanities, and no longer the attitude which once prevailed when faculties of engineering schools were inclined slyly to ridicule any other than technical studies. I recall a professor of mathematics who advised his students the only Greek worth knowing was enough Greek letters to name the angles of a triangle. He might have added, or to identify one's fraternity! Engineering students, at least in my day, seemed to welcome the dictum of such an authority as an excuse to avoid taking up any other than technical studies.

But even when he is wisely advised, even when he has some appreciation of the advantage of broad education, the engineering

student is confronted with technical courses so heavy that he has very little time to devote to any other than technical studies. The amazing thing to me is, not that much is omitted from the usual four year curriculum for engineering students but that you educators have been able to crowd so much into the short space of time at your disposal. I have no doubt that many of you have pondered over the question as to whether it would be better not to crowd so much in.

I realize there have been times when the demand for early vocational training has been very insistent. Even though you regarded such vocational training as premature you recognized the grinding necessity upon certain students to develop an earning capacity as soon as possible.

In my college days some engineering colleges purposely provided terminal courses. After one year's work the student could qualify as a first-class land surveyor; after two years' work he would have completed the studies necessary to fit him for railroad engineering. You provided this vocational training for men who must have a livelihood, but I cannot think you regarded it as broad or ideal education.

The work of the engineer covers a wide variety of endeavor from what might be termed the skilled artisanship of surveying and similar efforts requiring intelligent manual dexterity, through experimentation, design, preparation of plans, specifications, the direction of construction, the control of operation, the sale of engineering products, to the administration and executive direction of engineering undertakings. It is difficult to generalize for efforts so widely dissimilar.

Evidently the demand is upon you to provide in four short periods of less than a year, training which will include all this wide and varied field of effort. So the student, who may, because of his predilections, need much encouragement to broaden and humanize his knowledge and interests is burdened with such technical courses that he hardly can find time for other studies.

Shall we follow him after graduation? The vast majority of engineers work all their lives for salaries; so this graduate will get a job in an office or field party. He receives direction from a chief of party or a chief draftsman and spends his days working with other young engineers. He does not come into contact with people, with individuals. It may well be years before he has occasion to deal with outside people even with relation to engineering work.

Compare this with the experience of the young men of other professions. The young lawyer's first job is likely to be the making of collections, or perhaps handling minor disputes in Justice

of Peace courts. He comes at once into contact with people, with their problems, their troubles, their weaknesses and prejudices. He learns that few things are absolute, and that, viewed from various angles, prospects may be widely dissimilar.

The young doctor, in his one or two years of internship, is brought at once into contact with people as individuals. He realizes he cannot consider them merely as intricate mechanisms needing adjustment, but that each individual has his own characteristics and must be understood as an individual.

The young clergyman in city mission or small country parish comes to know his parishioners in person, and each one's aspirations, hopes, weaknesses, follies, and something of the good and noble that is in each one's life.

These are broadening and humanizing experiences. It is very natural that people should turn for leadership in matters affecting their lives and welfare to those whom they feel understand their troubles and difficulties, and who in fact do have a sympathetic understanding of the many problems of many different people. The business man, the tradesman, the buyer and seller, in his preparatory years has these same contacts with people. Under ordinary circumstances the engineer does not.

The engineer has very few individual clients or customers. He may provide water for a whole city and never come into contact with a fraction of one per cent of the people who drink it. Sooner or later almost every one has to call on a lawyer, a doctor. a clergyman; but most people can live and die happily without ever having personally to employ an engineer.

The uncertainty of tenure of location I previously mentioned, inevitable with much engineering work, makes it difficult for an engineer to strike deep roots in a community, to become a neighbor, one who dwells in our midst. Identification with a community takes time and cannot be developed in a year or two, or even in many years if one is away a half or three fourths of his time.

These general conditions under which the engineer lives and works seem not likely to much change as society is now organized. Technical work concerned with construction must be intermittent. No character of education can solve the problems of technological unemployment. More continuity obtains in positions of semi-technical employment, those wider fields available to men who have the background of thorough technical training and who also have something else. That something else that makes them broader, something more than technical experts.

It seems logical to conclude that if the engineer by the nature of his early work is to be deprived of the humanising experiences

of contacts with people, this deficiency should be compensated for as far as possible during his college years of formal education. This may well require eliminating some of his technical and vocational training.

It was with much diffidence that I accepted the invitation to address you because I was asked to criticize methods of engineering education. That I am not qualified to do. I am not familiar with present-day methods or curricula. I can only comment on the products of some engineering education of the past and leave you to determine whether your present-day methods may produce similar results.

Instead of criticizing I want to take this opportunity as a practicing engineer to pay a tribute to you engineering educators for your large contributions to the engineering profession. Your reduction of practice to textbooks, your compilation and organization of data, your researches in laboratories, have contributed greatly to the advance of the profession, to the development of new techniques. You have held high the standards and nourished the ideals of the profession.

In your educational fields you have wrestled with every new problem of adjustment of education to changing conditions. There must have been much wise compromise, the kind of compromise Browning referred to as "refusal to sacrifice the possible good to the impossible best." The whole engineering profession should and I believe does honor and revere the engineers of education and I am happy to express this honor and this appreciation.

In the past twenty-five years or more I have had to do with the employment and have observed the progress of a great many young engineers from many different colleges. Some had a smattering of specialization, for instance, we had two or three men from a college where a professor had formerly worked for a bridge shop, and his men had taken precious college hours to become half way detailers. Others came from colleges where the emphasis had been laid on a thorough grounding in fundamentals, characteristic of some foreign universities. Their showing during the first year often did not equal that of the men with the bit of vocational training. But with their thorough grounding they soon mastered the technique and, on the average, in the long run, far outstripped their fellow workers.

When a young man just out of college comes to my office and says "I have specialized in college in bridge engineering," I begin to wonder how broad and thorough his foundation may be. I suppose from the same college others have specialized in sanitary engineering, or water supply, or power plants, or railroad work, or highway engineering or any one of twenty other specialties.

In my opinion it can't be done and isn't worth while. For instance, we think a man is doing very well who can become a first-class detailer in a year or more of steady work all day long every day, for which he is being paid. It takes months, not hours, of training—and the few hours' preliminary training he could possibly have in college had better be devoted to something else.

To those who may not know this particular work I might say that detailing is engrossing and fascinating work. It requires imagination and visualization, the consideration of the practical problems of how the work can be done, and often intricate and complicated calculations of stresses and strengths. When a man can turn out a sheet of details so accurate that a checker can verify every item and mark it approved without the change of a figure, that man can be trusted to undertake the design calculations for larger elements of a structure. Of course, it will be a long time before he can develop judgment to originate a complete design.

If I am merely restating what may now be accepted as axiomatic you will find excuse in my long absence from collegiate halls. At least these views have not always prevailed. No one can take a young man from high school or preparatory school and make him into an engineer, much less a specialist in four or five or even six college years.

The best that can be done would be to teach him to think; to teach him to study; to teach him where to look, how to find and how to weigh and analyze and make use of special information he may need; to ground him thoroughly in the great fundamentals underlying all engineering; and to teach him thoroughness.

The principal weaknesses in possibly seventy-five per cent of young engineers are inability to think independently, and lack of thoroughness, and failure to conclude any task. Most of them cannot be depended upon to do the last ten per cent of the job, someone else must review it to see that it is finished. Too many think that an understanding of principles is sufficient. Correct principles and incorrect results are of no use in engineering as a business. The correct answer is more important than the method by which it is secured.

I submit then to you educators the question whether you can provide for the engineer during his college years training and study and experience that will compensate for the lack of human contacts in at least the first years of his practice. Is it not possible by eliminating some of this attempted premature specialization and by confining technical training to fundamental matters, to find time and to make room for cultural subjects, for humanizing studies, for public speaking and debate, for a participation in gen-

eral activities which will bring the engineer student into close and intimate contact with others who have other interests in life, to require, not merely permit, social activities which will develop a "savoir faire"? Many engineering students are inclined to be reticent and shy, and to carry this through life, often setting up a defense mechanism of brusqueness and ill-bred behavior.

I have been interested and amused in attending social activities, dinners and receptions of groups of older engineers in eastern as well as western cities, to note the lack of social ease so generally evident. There is a marked difference between a social gathering of engineers and a similar social gathering at a bankers' convention or at a Bar Association banquet.

The question has been asked whether it is not a proper function of a college to turn out graduates as gentlemen with some sophistication and bearing, and it has been alleged that from some institutions, particularly engineering colleges, the finished product is only slightly different from the raw material and some of that is pretty raw.

If at least one half of one's hours while awake are devoted to other than technical vocations, it means one half of one's life is applied to other than business activities. Is it not desirable that our institutions of higher learning should give some guidance or even definite training which will apply to this one half of our lives? Perhaps you have courses in deportment, in social behavior, in an appreciation of the amenities of life. They would be helpful to many.

With four years of work largely so general in character, engineering instruction must of necessity be reduced to the fundamentals. I should say these would include (1) the technique of instruments, (2) mathematics, (3) mechanics; and the mastery of all should be characterized by thoroughness, orderliness and accuracy. By mastery I mean real mastery, permanent retention, and not merely passing grades.

The young engineer needs a knowledge of and some reasonable facility and expertness with the instruments of his profession—surveying instruments, drafting instruments, calculating instruments, testing equipment and the like. He is likely never entirely to lay them aside.

Mathematics, the great tool of the engineers, should be made a familiar implement, something to be used with readiness and ease. Calculus should be mastered until it becomes the natural, preferred and easy method of problem solution. I must confess calculus never became for me a handy machine; in spite of my reviews and studies since college days I have always been clumsy with it and inclined to adopt more arduous algebraic and other solutions

where possible. Perfectly ridiculous of course; if one can use a power saw or automatic lathe, there is no sense in chopping wastefully and clumsily with an axe. In college I think we regarded calculus as an end rather than as a means to an end. Perhaps we were too much concerned with its abstractions and did not find enough applications where the answer meant something to us.

And mechanics should be taught and retaught, studied and learned until the principles can be applied to any problem, until the principles have been ground in and cannot be forgotten. Everything goes back to pounds and feet per second. Regardless of what branch of engineering may claim our interest, here, in general mechanics, we find the basis of it all. In his notebooks Leonardo da Vinci refers to mechanics as the "paradise of science in which we find the fruit of mathematics." I am afraid some students of my day tried hard to escape from that paradise and thought the fruit largely sour apples.

If the student wants to take further technical work let him do that technical work in a postgraduate course; but if he has been thoroughly grounded in his undergraduate years I believe, generally speaking, he can get the specialized training better by working in actual practice in an office. I have observed that men find it easier to go forward with their studies along the lines of their special employment, than to go back and review and ground themselves in a complete mastery of mathematics and mechanics while they are carrying on with practical tasks.

I wonder if you educators fully realize what an influence you have on your students, how much longer general impressions last than what you teach—your bearing, your attitude, your character. These are what your old students remember. Not infrequently I hear older engineers chuckle and laugh at some of the engineering ideas of their old professors and comment on the limitations or perhaps error in what was taught. But nearly always there are expressions of affection and appreciation for the character of these same professors, and it is evident that the personality, the character, the high purpose of men such as you have here, become much more a part of the lives of these old graduates than what was taught.

This is a heavy responsibility—for conversely the mistakes a professor may make in these fundamentals may be much more serious than incorrect instruction. May I cite an instance for illustration? The son of a rather prominent and wealthy man was graduated from a college of engineering in an Eastern State. One of his professors, doubtless a young professor, wrote to the father: "Your son has a brilliant future. His graduation thesis shows a grasp and mastery of engineering that few engineers with ten years

of practice could equal." The proud father showed the letter to the son; the son thought his professor was right and started out with mistaken ideas; I am convinced that letter was a considerable contribution to the failure he became.

In the years I have forgotten the professor's name, for I saw the letter, but that professor was a plain fool. Let us be frank. No engineer who has been practicing for ten years can possibly know as much about engineering education as the engineer who has been teaching engineering for ten years. And conversely no engineer who has devoted himself to teaching for ten years can possibly know as much about the practice of engineering as the engineer who has practiced for ten years. No college training can take the place of years of experience. Any professor that would write that letter obviously does not know anything about what engineering practice really is. The only honest and rational thing to say is that when these young men leave you they are in the way of becoming engineers.

An engineer might be described as a man who is not embarrassed in the presence of raw materials. I commend that rather cryptic remark to your consideration. The imagination to conceive a finished structure to be constructed in a wilderness of space, from a chaos of earth and stones, with easy confidence and understanding of how the transformation will be wrought, is the natural function of the engineer. It is not surprising that many men have a feeling of rather helpless dismay when confronted by such circumstances. The roaring torrent to be dammed, the yawning abyss to the spanned, the precipitous mountain flanks to be traced by road or railroad may well present hopeless obstacles to the average observer while to the engineer they are but challenges to his ingenuity—he instinctively begins to plan solutions. I think we may correctly say the engineer is one who is not embarrassed in the presence of raw materials.

In like manner I think the educated man might be defined as one who is not embarrassed in the presence of cultivated and cultured sophistication—who is not embarrassed in the company of men and women of any walk in life. I know I have heard many clever and epigrammatic definitions of the educated man. Unfortunately I cannot remember any of them.

In a recent discussion with a group of men of affairs the conversation turned on the value of the study of Latin, of philosophy and of other subjects ordinarily regarded as having little practical value. One of those present, an attorney of wide experience, expressed his views in about these words, "I have been thrown with many men, men of intelligence and accomplishment—some college men with the foundation of the old classical education, others who

had developed themselves without formal education, and I have studied and weighed them. It is my conclusion that the educated man has the advantage of knowing what it is all about," in other words, a man not embarrassed in the presence of learning or of educated and cultivated people.

I hope the time may come when engineering will be recognized not only as a technical profession, but as a learned profession, when the engineer's preparation will fit him for a place in organized society not only as a technical expert but one of broad and comprehensive interests—men who can recognize a symphony and appreciate a picture—men who can have the fullest and most delightful lives because they touch life at many points—men who can have the close fellowships of common interests with their fellow men.

The name of your Society might be interpreted as having the object of increasing the number of men technically trained as engineers, or of raising the standard of education of those who are or are to become engineers. The numbers may already be too many. The standard of the education can never be too high. Every advance which makes for the broadening of the education of engineers will make more effective his contribution to society, more certain and definite his place in organized life, and more wide and beneficial his influence, and the probity and honesty that comes from dealing with the laws of nature will be a spreading leaven in the troubled problems of organized society.

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CORRECT LENGTH OF THE ENGINEERING COURSE INCLUDING GRADUATE WORK AND DEGREES TO BE AWARDED THEREFOR *

By R. W. SORENSEN

Professor of Electrical Engineering, California Institute of Technology

These are days when we, who are responsible for educating future engineers, must consider very carefully not only the correct length of our engineering courses but should also give careful consideration to their content, the objectives toward which they carry us, and our students.

If our engineering colleges were responsible only for the training of efficient designers, builders, and operators of machinery, the problems incident to that work would be relatively simple, as we would then have need to select only the proper course and exercises which would train men to build quickly and at a reasonable cost the machines we need and, having built them, to find ways and means of operating them in the most efficient manner. Fortunately, however, our ideals are higher than those bounded by such limitations, for we have long recognized that we are not solely in the business of making engineers, but are rather in the business of educating citizens who can solve some of the world's problems by engineering methods. For this reason, few if any of us have permitted our curricula to become such as to train only for slide-rule and handbook or machine craftsmanship, but have realized that such forms of education when possible should be left in the hands of vocational schools either private or public, as the case may be. In California ample provision is made for this work by our Junior colleges and some other institutions.

The Junior Colleges and the Trade Schools that are doing the quality of work I consider satisfactory are for the most part new, but they are as a rule doing well the job of fitting men for operational and construction tasks, such as drafting, surveying, assembling, operating machinery, etc. The courses given in these schools are usually two years in length, thereby saving for many men, who might otherwise have to take a four year course to get the work desired, two years of their time and much expense in the preparation for work for which they are qualified by aptitude and desire.

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The teachers of such courses should, of course, be competent engineers who are college graduates and have had practical engineering experience long enough to enable them to correlate properly the work they are teaching with our longer college courses and the ability of their students, thus making possible proper student placement, including giving advice which will direct well qualified men, who should take the more complete course, into taking those courses rather than the two year craftsman training, which when it absorbs men who show ability to do the more advanced work, results in a loss to society and disappointment to the man of greater ability limited by his training.

On the other hand, many men who now have engineering positions where the work is of routine nature in the office or factory and who have spent four years in college would, had they taken the shorter, strictly technical course, have a much better attitude toward their work and would be as well qualified for the work they are doing as is the case after having spent four years or even more in college. Fortunately, not all the men in these sub-engineering positions have over-invested as to time and money in college, because many of them did not complete the four year courses for which they enrolled, but found places suited to their tastes and, being men who know what they want to do, are in many cases filling better places than are their associates who completed the full four year courses. This situation causes me to be very definitely of the opinion that the shorter technical courses, teaching engineering craftsmanship for both office and shop, should be recognized and made a part of a comprehensive engineering educational system. This must be done because engineering is an all inclusive term and does not at all imply a profession made up only of men who are doing research and creative work, though I am sure you will agree with me that in all its fields it does useful work. When we have more high-grade, well-manned sub-engineering schools which provide opportunity for all who wish to take the craftsman courses, the four year engineering colleges will be more free to arrange curricula than is the case at present, because the present urge to introduce professional subjects of use to craftsmen, which goes with the four year courses will have been eliminated. In fact, even with this urge, we have found it impossible in our engineering colleges to have many of the professional subjects given before the third year. This suggested arrangement which has been tried out by some engineering colleges, opens the way to provide more time for humanities in the first two years of all engineering courses and also allows more time in these courses for chemistry, mathematics, and physics, thus making possible more thorough instruction in these foundation courses than is often given

in our four year engineering courses. Furthermore, since the craftsman type of engineer has been well provided for in the vocational school, some of the specialization work and intensive technical training now given in the senior year of our four year engineering courses may well be omitted and the time thus provided applied to a continuation of general educational studies in humanities, including accounting and economics, and in other fields of science, such as geology, biology, etc., thus allowing men taking these four year engineering courses to be better trained and selected with regard to their ability to find human interest in contacts with non-technical citizens. Men so trained will in all cases have a sufficient technical background to do well much of the work done by the engineer but which does not call for specialized training.

To illustrate by an example in my own field, that of electrical engineering, it seems to me there is really little reason for giving a course in Transmission Lines or Operational Calculus to every man who graduates from a four year engineering course, because by and large only a very small percentage of electrical engineering graduates are ever actually engaged in professional work with transmission line problems and problems closely related thereto or with problems requiring a knowledge of operational calculus.

Assuming the plan as outlined a sound one, there is immediately the necessity of providing the more technical man with additional work after the four year engineering course has been completed. In general, one year of additional work provides the student with a rather convenient stopping point, though it might be better to make the standard Master's course require two years subsequent to the work of the Baccalaureate degree, as in this way course work can be made less intensive so as to provide the student with greater latitude in his choice of the use of his time. Also, in the Master's degree course some time should be set aside for non-engineering subjects, perhaps history, English, or some phases of business economics. In this Master's degree course the technical work of the third and fourth year can be amplified and some specialization permitted. If, however, there is to be much specialization for a student while he is in college, it should be deferred until after the fifth year and the specialized courses should be open only to men who have shown ability in mathematical analysis and the originality which warrants encouragement for continuation in college two or three years beyond the fifth year, thus making a total of seven or eight years devoted to work in engineering, which should, of course, be supplemented by some work in the practical engineering field.

A curriculum which plans for such a great length of time devoted to its preparation should be undertaken only after very care-

ful consideration. Such a plan is not without precedent, because we find that other professions, such as law and medicine, require seven years or more of college preparation before one entering these professions is considered ready to practice them.

Furthermore, education has been defined as that which enables one to better enjoy his fellow men and his natural surroundings; hence, it would appear logical to recommend that a person seeking an education devote as much time to the process as possible in order that he may cultivate more and more phases of life, and thus be enabled to enjoy more and more of the natural things with which he comes in contact. Also, I am at this time strongly of the opinion that one is justified in continuing an educational program as long as that program can be followed with enthusiasm and brings to the individual pursuing it joy in the performance thereof. Of course, very naturally, the question of financing such a program is one which must be taken into account and may even be the factor which determines when a college course should end, though finance should never determine the time for ending one's study program.

Furthermore, while I am not an advocate in any way of the mysterious "technocracy" plan, the human race has certainly been accumulating during all our recent developments a great fund of leisure time. In general all discussions relating to this so-called leisure time have been conducted on the basis of a reduction in hours per day and days per week. For many persons, however, it may be possible for leisure time to be accumulated and made available as a lump sum, as, for instance, the sabbatical year which in some colleges is a regular affair. With such an accumulation of time available, it would be used by many engineers as a time for another year in college devoted to a program of study and research. Any comprehensive engineering education program, therefore, should include a number of engineering colleges in which lecture courses, problem courses, and research facilities can be found that will attract engineers of any age and any degree of experience, thus making possible opportunities for engineers who wish to do so occasionally to take a year or two from their regular work during which time they return to college for contacts with men and equipment to be found there. In other words, I am of the opinion that engineering courses should be indefinite in length and that provision should be made for a continuation of residence within college walls for as long a period as desired by enough individuals to warrant such continuation. Furthermore, I am at the same time of the opinion that certain engineering training courses less than four years in length should be provided; that our four year courses should be very general, containing much work that is not technical, and these courses should be considered not as professional courses,

but as fundamental, broadening, educational courses suitable as preparation for any walk in life and for any profession conducted during an age when all our daily acts of living involve the use of mechanical and electrical devices.

The four year engineering courses which, though not officially adopted as such, have become by use over a long period of time more or less standards, will no doubt continue for another generation as the courses which will be taken by the majority of our engineering students. But the present trend of affairs indicates to me that our four year engineering college course will continue to add humanities and supplementary subjects until these courses for the most part become general educational courses with a scientific or engineering background. These courses will be supplemented by sub-engineering courses of two years conducted probably largely by our Junior Colleges, which will train the craftsman type of engineer for office, factory, and plant operation. Our standard four year engineering courses will also be supplemented very generally by graduate courses of one or two years leading to the Master's degree or its equivalent, and by more advanced graduate courses.

What degrees shall be granted for the completion of certain work in engineering? It may well be said that this feature is almost as essential as that of planning the course, because there must be suitable rewards for tasks accomplished. In many cases, of course, the accomplishment itself is the reward and perhaps the ideal would be to make this applicable throughout to the educational program and avoid entirely the granting of degrees. At the present time, however, custom decrees otherwise and though we must not in our educational work permit ourselves to become slaves of custom or tradition, practical considerations require a certain amount of conformity thereto. Hence, though there may be no good reason for the custom of granting degrees, we find that human beings have long observed the custom of dividing educational programs into certain steps which, unfortunately, are often marked by years rather than by accomplishment and at the completion of each of these steps there has been established the custom of awarding degrees such as the Bacealaureate degree for the completion of a four year college course. My limited reading of the histories of education, has not shown me as yet any good reason other than that of custom as to why our American schools are divided as they are, although it can well be said that many of the very old plans of educators called for certain divisions of courses very much like those which we now use and which are almost world-wide in scope. Furthermore, there is no apparent practical gain to be made by proposing any entirely new plan of educational division around

the college courses, although there has been, of course, considerable change in work below that of college grade, the indication now being that the 6–4–4 plan will become the universal one. The complete adoption of this plan may, of course, in years to come change our college work so that it begins with the present Junior year. For the present, however, I see no reason why the standard degree for our four year courses should be anything other than the Bachelor of Science degree or at least a Baccalaureate degree with perhaps the designation as to courses appended thereto. As, for example, I think at the end of our four year course we should grant Bachelor degrees and no professional degrees as Mechanical Engineer, Electrical Engineer, etc. This conforms with the requirements and practices of the American Association of University Professors and I am sure leads to less confusion than any of the other plans which have been used. By custom the next higher degree is naturally that of Master of Science, which may mean one or two additional years as the case may be, according to the college in which the work is done. Naturally work subsequent to that done in college, if custom is to be followed, suggests that the next degree be the Doctorate degree.

My own feeling in regard to this matter is that while there should be specialized engineering courses and a special requirement of work relating to engineering should comprise the thesis work of a candidate for the Doctorate degree, a considerable portion of his work should be in the field of the advanced natural sciences, particularly physics. If this be the case, the natural degree for such work seems to be the Doctor of Philosophy degree with the designation in Civil, Electrical, or Mechanical Engineering, as the case may be.

I should like also to be able to make some definite suggestion as to a degree for the sub-engineering course, which I have designated as the craftsman course, but have been unable to decide upon a satisfactory name for such a degree and must, therefore, leave that for further consideration.

THE ENGINEER'S DUTY IN AN ECONOMIC WORLD *

By J. S. GOULD

Professor of Economics, University of Delaware

Conspicuously placed on the bulletin board of Evans Hall is a definition of engineering reading "Engineering is the art of organizing and directing men and of controlling the forces and materials of nature for the benefit of the human race." It seems to me that if the definition is an accepted statement of what engineering is, rather than what it should be, then the phrase "for the benefit of the human race" establishes the ultimate purpose and justification of the profession of engineering. Hence it would be perfectly proper to insist that the engineer has a duty in this economic world. Now what is this duty? It is certainly not merely the application of the forces of nature to materials, and the organization and direction of man's energies. For what purpose? To benefit the human race is the definite and clear objective.

There is no denying that what we call modern civilization, its most conspicuous aspects at least, is the direct result of the engineer's skill in the translation of the findings of science into material realities. In many respects our civilization has been enriched materially by the engineer's technique. However, these results have been achieved in an indirect manner, more as a by-product of industrial and financial leaders' quest for profits, rather than the engineer's conscious desire to achieve the expressed objective, namely the benefit of the human race. With the exception of certain outstanding leaders in the profession, most engineers are not fully aware of their duty, which, as it seems to me, should go beyond the necessary loyalty and service to employers, and embrace the larger unit, society.

In discussing the development of the engineering profession and its relationship to organized society, the late Thorstein Veblen said:

"It would be hazardous to surmise how, how soon, on what provocation, and with what effect the guild of engineers are due to realize that they constitute a guild, and that the material fortunes of the civilized peoples lie loose in their hands. But it is already sufficiently plain that the industrial conditions and the drift of

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conviction among the engineers are drawing together to some such end."

This statement from his "Engineers and the Price System," the book that became the veritable Bible of the recently eclipsed Technocracy advocates, further substantiates the claim that the engineers, in the practice of the profession, must assume a larger responsibility than the mere efficient execution of the task at hand. In other words, the engineers have a duty in this economic world of ours, namely, the utilization of their native and acquired skills for the benefit of society. This necessarily involves the development on the part of the members of the profession of a greater social consciousness, the giving of preference to the social rather than to the individual point of view. In other words, the engineers must become more socially minded.

In discussing the "duty" of engineers in an economic world, there inevitably appear for consideration certain ethical implications, differentiations, etc. At this point it may be worth considering the difference between the duty of the engineer in the modern world as contrasted with previous periods in human history. Engineering of course is not new. It goes way back to the dim days of antiquity. The engineer we have always had with us, although he did not play so significant and conspicuous a rôle as in modern times. When in the dawn of civilization some unsung genius, by design or accident, came across the realization that he could to some extent utilize the existing forces of nature for the purpose of improving his own condition, engineering of a crude sort began. When man learned to fashion tools, domesticate animals, utilize the forces of nature, he was in a limited way developing the arts of the engineer.

The essential difference between the engineer of modern times and those of previous civilizations seems to be not only one of degree in knowledge of science and skill in technique, but also one of purpose and point of view. The engineers of ancient Babylonia in constructing the hanging gardens, were utilizing their skill primarily for the benefit of the ruling king. The same can be said of the engineers of the Egyptian Dynasties, who left us such puzzling remains of their ingenuity that debate still goes on as to just how the pyramids were built. In the Roman Empire, the engineers applied themselves to building aqueducts and roads so well that evidence of their skill is still present. However, it was done primarily for the ruling Caesars, and only incidentally for the benefit of society as a whole. Even in the Middle Ages, when the energies of man were primarily devoted to the construction of great cathedrals, the engineer's point of view did not embrace the whole of society.

His duty in previous ages was entirely different from what, it seems to me, it should be in modern time. The economic and social complexity of the world of today is largely the fashioning of the engineer. This is the machine age, and the engineer, to a considerable extent, is its maker. It was during the industrial revolution that engineers developed the method of inventing, and by the application of the findings of pure science together with the use of accurate measurements they created the existing industrial machine. Unfortunately, the engineers stopped merely at creating the machine, and did not take much trouble until very recently about learning how to control it for the benefit of society at large. In limiting themselves primarily to the production of goods with the minimum of effort and the greatest efficiency, they failed to give attention to the purpose and object of producing goods. It is only within the last fifty years or so that engineers have entered into the field of executives and administrators, and hence have some say as to what goods shall be produced, how, and why.

The engineer has acquired the means of utilizing science, but he has only partially fulfilled the promise implicit in the definition of engineering, the utilization of his skill primarily for the benefit of the human race. The reason for this failure is perhaps in the fact that the economic world has been controlled and is being controlled by a political and economic philosophy quite contrary to one that should be developed by the engineering mind. The engineers have allowed political science of the 18th century and economics of the early 19th century to determine the way in which their skill in organizing men and utilizing the forces of nature should be done. My plea is that the engineer should become not only more socially minded but that he should also come more into a position where he can actually utilize his art and direct it for the benefit of society.

We have at the present time many problems with which the economist, social worker, political scientist, politician, and business man is grappling. Such problems as unemployment, the displacement of man by machines, wages, hours of work, surplus production, and numerous others arising from the peculiar workings of our present economic society are ones with which the engineers should be very much concerned. An engineer has been trained to look at things not emotionally. The engineer will examine, measure, test and go about that test in a cool, calm manner. Such a type of training would help much in an approach to the solution of our problems. Since the engineer is so largely responsible for the character of our industrial system, he should be trained to appreciate the problems that are the direct result of its operation,

and should be given a larger share in determining the way it will continue to operate in our economic world.

The purpose of the engineer is not justified in the making of "two blades of grass grow where one grew before." When man was struggling with the forces of nature and was barely able to maintain even a very low standard of life, any achievement in the direction of increased production of goods was a welcome relief from the pressure of the "scarcity fear." Now, with the rapid strides in engineering technique, we can produce sufficient goods to supply the needs of practically all the people in our country, and there should be no suffering from starvation. The engineer now knows well how to produce, he has yet to go into the more difficult field of proper distribution of the goods which he produces so abundantly. The questions of, How can the engineer reduce lost motion? how can the engineer reduce waste in material and man power?, will have to be supplemented with the more important question, For what purpose? True, goods may be produced more cheaply, conveniently, and with the least amount of time by reducing lost motion, but what will happen with the time saved? What will be done with goods that are produced?

I believe the time is coming when the engineers will realize they constitute somewhat of a guild, and like the guilds of the middle ages, they will be responsible not only for the training of their members, the conditions of work, but also for the welfare of the consumers who constitute the largest portion of society. The engineering profession must become aware that the engineer's duty does not cease when he has learned the art of producing goods. He must become more socially minded. He has a more important rôle to play in the economic world than just producing goods.

HUMANITIES IN ENGINEERING EDUCATION*

By HALE SUTHERLAND

Professor of Civil Engineering, Lehigh University

Professor Gould has set forth in masterly manner the social responsibility of the engineer. This realization of responsibility for the functioning of the mechanized civilization of his creating has come to many engineers and the theme is abroad at all gatherings of the profession for many months past. We are beginning tardily to realize that the democratic state requires a trained citizenry and that the engineers form a large group who may be of peculiar importance and influence in the social community by reason of their method of solving problems as well as by reason of their peculiar responsibility for the applications of science to life which characterizes our modern society. We have been inhibited from putting preparatory courses in citizenship into our technical curricula by reason of our already crowded programs which still fail to embrace all we wish to teach—and by our naïve belief that social responsibility can be well exercised without training. The old Jack-of-all-trades idea survives from pioneer days—with disastrous results socially. It is time we did something about this for the situation calls for action—for a reshaping of engineering curricula to fit our graduates for group life as well as for individual vocational advancement. It is possible that the two go together; that the broadly trained man will rise to higher posts than his technician fellow. I am going to review some of the arguments for a liberalized engineering education and point out an easy way by which we may proceed and do that liberalizing. I hope that action will result from what we say here. Dr. Gould has supplied impelling reasons for our professional social responsibility. I shall add demonstration of the logically resulting demand made upon our curricula—and by great definiteness I hope that we will be persuaded that living up to our educational responsibility in this matter is comparatively simple and easy of execution.

In his Sigma Xi lecture at New Orleans in December, 1931, C. F. Hirshfeld, Head of Research for the Detroit Edison Company, put the situation very bluntly: "I am convinced that the major

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ills of the world today and for some time past are due largely to those of us who have advanced science and the application of science and who have almost criminally refused to give serious thought to the collateral results. To my mind it is our fault that a civilization capable of producing a surplus of food stuffs, of material goods required for living and even for luxuries, for all who are willing to work, finds itself beset by all sorts of little understood economic upheavals, wars and social rebellions."

Are engineers in the future to repeat these mistakes of the past, work blindly without regard to the social consequences of their technique, play a negative part in the evolution of the social organism which is now proceeding at such accelerated pace? Or are they to take an intelligent and constructive part in directing and shaping the forces of change, perhaps even come out as leaders and apply their scientific impartiality to human problems as they now apply it to mechanical achievement? The answer in part depends upon the sense of social responsibility instilled in our engineering students by our schools.

In the past the engineer has been a technician who served the state and industrialist—putting his technical ability at their call and building as they directed. Unless some radical and unexpected change comes in our social order this status will continue. There is much room for constructive social leadership even thus, and the engineer like any other private citizen may play as large a part in community affairs as he elects and his abilities permit. It appears that there is considerable stirring among engineers which would urge the individual to greater personal interest in civic life and it seems likely that the present and future generations of students in our technical schools will take their duties as citizens more seriously than we of our day have in the past. Whether or not that be true it is certain that there will be no halting of the process which increasingly is bringing engineers to high executive positions in the business world. Engineers tend to replace lawyers as industrial leaders and these successful individuals are becoming responsible for business policies of the most far reaching social import. It seems certain that in the future this inevitable leadership will act with greater social wisdom if today there is definite training for responsibility. It is on this theory we proceed in all duties of life. It would be foolish to urge that the placing of social science in the engineering curriculum will ensure the later social wisdom of those engineers who rise to high post in industry. It is obvious, however, that the inevitable engineering leadership of the future will be marked by social ignorance if it is trained only in technical matters. A literary celebrity remarked recently that the trouble with America is that her in-

dustry is dominated by self made men. It is often true that men who are self-made in their knowledge of social science are dogmatic and uncritical, ultra conservative in all their judgments in economic and political matters. Without historical perspective, they tend to assume the scene most immediate to their view as the natural state of man. The only alternative to utter chaos of thought, such as now characterizes most discussions of the current economic crisis, is study of the origin and evolution of western civilization, the discovery of the dominant ideas which shape it and the forces which are at work in the constant flux of the pattern of civilization, and, of course, study in detail of organization and function in the economic sphere. To argue the ineffectiveness of this training is to assert that intelligence for man's control of his own destiny is lacking, is to assert the doom of modern civilization. The only hope for the successful continuation of the immensely complex machinery of western life is intelligent control. Intelligent understanding in this field comes only with study and thought.

The investigation of engineering education conducted by the Society for the Promotion of Engineering Education from 1923 to 1929 went far toward establishing the principle that the undergraduate engineering curriculum should contain "humanistic, scientific and technological studies—combined into an orderly whole" (Second Report of the Board of Investigation of Coordination, S. P. E. E., June, 1927, p. 122 of the final volume, 1930). Complete assent to this doctrine of a liberalized engineering education does not yet exist. Many schools accept it only to the extent of a year of English composition, a half year of economics, and perhaps a half year non-technical elective. The lack of complete acceptance of the need of the non-technical makes necessary further presentation of the arguments. The Preliminary Report of the Board of Investigation and Coördination, issued in November, 1926, is quite explicit in its statement. The engineering curriculum should contain "those elements of liberal culture which serve to fit the engineer for a worthy place in society and to enrich his personal life." "The development of greater social insight and a larger sense of social responsibility should be a definite objective of the engineering profession. . . . The ability of the engineer to extend his influence in industrial organization and in public life, to claim his due share of leadership and to discharge more adequately his function in society at large, now appears to hinge primarily on his attainment of greater competency and greater recognition on the economic and social side of his work." Primarily, then, in the thinking of Mr. Wickenden and his associates, the non-technical work of the engineering student is to broaden his social outlook and sense of social

responsibility; it has a broadly utilitarian purpose and does not relate to any dilletante attempt at aesthetic or literary culture. It does relate, however, to culture in the more dignified and proper sense of the word, that attitude of dignity, comprehension, sympathy, tolerance and good will which characterizes certain superior individuals. It was of culture thus conceived that the Wickenden committee wrote in their second report, "The assumption is commonly made that certain subjects are inherently cultural and others are not, and that any degree of professional orientation puts a program beyond the pale of 'broad' education. These assumptions seem to be incidental to narrowly conventional definitions of culture. The engineer would maintain that culture cannot be restricted to the fine arts and personal graces, however desirable for the enrichment of life, but must be conceived equally in terms of insight into the social bearings of one's calling, qualifications for efficient teamwork with men of other callings, and the ability to invest one's work with large social values. Culture, so conceived, ought not to be divorced from professional preparation."

It is evident at once that culture thus conceived is not merely a by-product of any and all educational programs. All studies are cultural in some degree that lead to larger comprehension of life. The most technical subject taught by one of large humanity acquires merit but more is required than intellectual honesty and vigor, the most common cultural by-products of technical study. In its broader reaches culture calls for social comprehension and social comprehension can be acquired only by arduous study of the immense complex bulk of social organization and conflict. In engineering thinking it is folly to attempt the solution of any problem without an understanding of the basic principles involved. A consideration of the specific cultural demands of the Wickenden Committee shows that they conceived of culture in terms of solid social understanding.

Regarding extent and content of the humanistic element the Preliminary Report reads: "There should be a band of humanistic subjects extending throughout the curriculum. . . . General economics is . . . a required subject. History, political science, and sociology are highly desirable subjects and deserve to be included. . . ." The Third Report continues: "In the choice of humanistic studies we hold that the primary criterion is not one of intrinsic cultural or intellectual values, nor one of narrow utility, but that of functional relation to engineering. English studies, both for facility of expression in speech and writing and for acquaintance with literature, studies which deal with the evolution and present state of social processes and institutions, studies

in human nature and conduct, studies in economics both social and technical, and modern languages for tool and colloquial uses, are to be regarded as integral elements in engineering education, rather than as preliminaries or addenda."

Since the S. P. E. E. investigation ended, Mr. Wickenden has succeeded to the presidency of the Case School of Applied Science. His application of the principle of liberalization should throw light upon the pronouncements of his committee of investigation. It is of note that the evidence is plain that he is not one who merely pays lip service to culture and regrets that the heavy demands of technical training prevent the inclusion of cultural subjects in the already heavily overloaded engineering curriculum. Case offers courses in Civil, Mechanical, Electrical, Metallurgical, and Chemical Engineering and in Physics—the several non-technical contents of which differ somewhat but not importantly. In the uniform freshman year, besides the usual work in English, there is a course meeting three times a week throughout the year, entitled, "History of Man's Cultural Accumulation." The course description merits our attention.

"This is not a course in history in the traditional sense, but is an orientation course based upon an account of man's constructive achievement. It deals with his positive accomplishments in political and social institutions, art, industry, science, and thought. Some emphasis is placed upon the historical development of science due to the relative importance of science in the modern world.

"The purpose of the course is threefold. In the first place it aims to explain the culture of the present by an understanding of its antecedents of the past. Secondly, it aims to give the student some grasp of the problems confronting the modern world that, as an engineer, he may approach their solution with some understanding and appreciation. Thirdly, it is intended to serve as a background for the other studies of the curriculum by giving something of the history of the various sciences and by showing them in their proper setting in the modern cultural scheme."

In the sophomore year in Electrical Engineering, taken here as typical, there is a three-hour course in economics extending through the year and a term course in literature and public speaking. The second term of study in economics follows a term of orthodox economic theory, and is devoted to labor problems: "A brief study of the aims, ideals, methods, and evolution of organized labor in the United States. Among the additional topics considered will be: scientific management, shop committees, methods of wage payment, profit sharing, coöperation, unemployment, labor turnover, trade agreements, strikes, industrial education, and industrial psychology."

In the junior year of this curriculum the only non-technical work is a three-hour a week, one semester course in technical writing. In the senior year, in addition to a two-hour course in business correspondence, three hours a week throughout the entire year is given to Engineering Administration: "The subject matter covered consists of engineering contracts and specifications, business organization, types of business units, analysis of problems of investment, first cost and costs of operation as well as business statistics, insurance, salesmanship and patents, and copyrights."

As we consider this Case School program it at once is evident that we have here a determined effort, first to overcome the engineer's ancient weakness, his inability to speak and write effectively, and second, to orient the young engineer in the modern world, both as regards his immediate industrial environment and with respect to the larger field of human affairs, economic, political, national and international.

This purpose of orientation of the graduate, orientation in the physical world, orientation in the human world of social groups of many sorts—seems to be the core of all educational aim in the modern college. Amid all the vagueness of aim which characterizes so many liberal arts colleges, the stronger schools are evidencing that of orientation increasingly. We are all familiar with the two-year course in Contemporary Civilization which Columbia requires of all undergraduates. The Dartmouth freshman courses are famous. More recently the University of Chicago has put into effect its basic two-year course preliminary to upper class status. Here we find very definite expression of the orientation aim. The work of the first two years proceeds along four paths, physical science, biological science, social science and the humanities. Physical and biological science acquaint the student with the physical world; social science and the humanities with the human world of thought and affairs.

The first task is already well done by our engineering schools: the second is that laid on them by the Wickenden appraisal. This added task is the demand that the engineering school give, along with a sound basic technical training, the essential humanistic elements of a liberal education. A closer view of the University of Chicago plan will show what one of our greatest colleges considers to be the essential humanistic elements of liberal training. Our view can be made very detailed if we wish for the University has prepared syllabi that cover all the required work in social science and one-half of that in the humanities.

The field covered by these two syllabi is often described by the single term, The Humanities, for example in the title of this talk.

The meaning attached to it by the Chicago faculty is the more accurate one and reserves to itself a distinct field of human interest, "those studies, which directed to the creations of the mind, embrace the thought, the art, and the literature which men have put forth in their attempt to arrive at the meaning of life." Comprehension of these creations can be had only as one knows and understands the social setting which gave them birth, the economic, political and other social forces which produced them. The syllabus leads thought to the religion, literature, art and philosophy, metaphysical, economic and political, of all the great epochs from the early civilizations of the Mesopotamian river valleys, through Egypt, Greece, Rome, the Renaissance to the present day. These streams of thought unite in that greater stream which takes form today in the institutions of our western world, a stream of thought which embraces all the loyalties and aspirations of mankind, those intangible forces which shape our civilization, those thought patterns which in reality are our civilization.

The faculty of the University of Chicago has done well when it has decreed that preliminary to advance in liberal culture toward that status of the educated man attested by the collegiate degree, is acquaintance with the humanities. Are engineers less in need of this foundation than others? Will their responsibilities be less so that their appreciation of human values may be left to chance? Much depends upon the scale of values of the man in authority. That it is which determines whether he be leader of men or autocratic tyrant. Properly taught—so as to make plain the human significance of the record, the humanities become a gate through which man may enter the large free world of the spirit, which we all must touch in some degree if our lives are to have dignity and worth.

Further, Chicago has demanded another attainment preliminary to entering the higher stages of preparation for baccalaureate status: sound acquaintance with social science, thorough study of the modern economic and political world and its growth out of the more immediate past. Today we are called to weigh many social theories; we have weighed and found wanting the naïve capitalism of 1929 and espouse mostly "reformed capitalism." So the University of Chicago demands that all modern theories be considered dispassionately, so that judgment as to methods of social progress may be made on a sound basis of fact and reason instead of by the usual process of passion, prejudice and class interest. Perhaps this is an overstatement—it may be that bias is too ingrained for eradication by any educational process. It is certain, however, that human progress is very closely a function of the exercise of unbiased intelligence. Hopeless or no, we must in all

ways possible endeavor to replace narrow prejudice with the scientific attitude of impartiality and action based on principle. The records of college graduates in public life are not such as warrant any great confidence that social enlightenment follows a college career but conclusions from this fact are hardly conclusive. It is doubtful that the curricula of thirty to forty–fifty years ago, when our leaders of today were college youth, contained any large systematic or realistic instruction in social science, or if such courses were available, that they were required for any considerable portion of the students. The question of the effectiveness of social science training in bringing social intelligence can not be answered until the experiment has been tried on a much larger scale than yet has happened.

Assuming that we admit that the humanities and social science must have place in the crowded curricula of vocational engineering learning, what can we do to accomplish our double purpose—the turning out of young men solidly prepared in basic science, mathematics and their elementary application to engineering practice and soundly conversant with the realities both of their immediate industrial environment and with the setting of that industry in the large pattern of the western social order? The engineering curricula of today have been proved effective technically by long years of experience and any large change is not to be thought of at present. In general it may be said that taking one three-hour a week course from the usual program each semester will leave a time allotment sufficient for the basic technical essentials. At Case, President Wickenden has done a little more than that. In the electrical engineering curriculum we have already referred to, there appear eleven non-technical courses, each three hours a week, except one, two hours, making about twenty-one per cent of the total program. At the Massachusetts Institute of Technology the allowance is not as generous; the allotment being fifteen per cent in civil engineering. The same course at Lehigh University devotes twenty-one per cent of the program to the non-technical. At the California Institute of Technology, which has a very carefully thought-out policy of cultural studies, these claim closely twenty-three per cent of the time of the undergraduate course in civil engineering. The demand for one course per semester asks for about sixteen per cent of the usual course. This seems to be the minimum for effectiveness and somewhat less than the technical work can lose without loss of vocational efficiency. How should this time be used?

In the Preliminary Report of the Board of Investigation and Coördination we read: "There should be a band of humanistic subjects extending throughout the curriculum. To increase the

range of such work available in addition to required work in English and economics, *much of it may properly be on an elective basis.*" Apparently most of those who were impressed by the arguments for the humanization of the technical school program read this last sentence with care and approval. Most responses to this new motive took the form of provision for a small amount of elective work in humanistic subjects. As usually executed the range of election has been wide and has covered such subjects as American Literature, history of architecture, foreign language, U. S. history, corporation finance, psychology, biology, astronomy, business correspondence, engineering reports, sanitary bacteriology. Such diffusion is patently at variance with the purpose of the humanities in engineering education. From two of the subjects named the student would depart with a keener understanding of a narrow range of the human world of affairs; the others would add to his appreciation of the world of art and nature and in no way ensure his intelligence as a citizen. The elective system fails utterly to provide education of the sort implied by all the arguments of the Wickenden Committee. The failure of our American technical schools in the field of the humanities was a failure to understand the real import of the Committee recommendations. It is all part and parcel of the great American delusion, the naïve faith that takes form in the notion that any man of moderate education is competent to take high office in government and control the complicated course of the modern business state. Any spell-binding house painter may rise to the highest—here as elsewhere. Citizenship is not seen as an arduous affair for the trained intelligence and the shame of many American municipalities is the result. Any subject in the offerings of a college of liberal arts is classified by the unthinking judgment as cultural broadening, and thus qualifying the student for the world of life. This sounds exaggerated, but the curricula of our engineering schools are proclaiming this thing for all that.

When the elective system becomes one of guided selection—with such coercion as may be expedient—the situation changes in some measure. For example, the current catalogue of Lehigh University contains in the description of the Civil Engineering curriculum: "While no program of humanistic courses is included in the curriculum, it is expected that the non-technical elective work of the junior and senior years will be chosen for the purpose of gaining knowledge of the great and ever pressing problems of human life, individual and social; accordingly all programs of elective studies must have the approval of the director of curriculum." These electives are five 3-hour courses in the junior and senior years, following a year of economic theory as sophomores. Existing

courses, however, give no possibility for any but a series of specialized studies in history, government, and business. No large view of the whole social scene is possible. In general this is the situation elsewhere; a modified elective system even with a program directed definitely to the purpose of social comprehension cannot accomplish its purpose because some phases of the picture are given too much attention and others must be neglected entirely.

A more comprehensive solution of the problem is suggested by the published syllabi of the University of Chicago in the Humanities and Social Science. Without changing in the least the balance between mathematical, scientific, technical and non-technical subjects it is possible in a curriculum organized along the usual plan to introduce the essentials of these two magnificant compilations with a result that in outline at least the engineering curriculum would contain the main essentials of all that the University of Chicago requires in these two fields of its students in arts before they proceed to upper class work. Pitifully small as is this step toward effective humanization, it is a long step in advance of present standards except for the few schools most persuaded of the case for the humanities. Whether effective liberalization is possible along with effective vocational preparation compressed in four years is perhaps uncertain. It does not seem than any more radical step is possible of consideration now.

The changes involved in this proposal are these: build the freshman course in English upon the University of Chicago syllabus for the humanities, recognizing that that syllabus is much more comprehensive than can be embodied in any of our adoptions. Where Chicago gives one fourth of the working time for a year to this subject the average engineering freshman would be expected to give the smaller fraction of about one-sixth. Those lads entering with serious disabilities in English composition must postpone this course until qualified. Any good department of English in cooperation with other departments, notably that of history, would be able to put on a competent and inspiring study of the flow of man's thinking down through the ages to its temporary culmination in the modern mind. The work in composition would consist of reports of historic and literary matters; and indirect English can be made effective as well as inspiring.

Following the accustomed economics, generally in the sophomore year, a three-hour a week course throughout the junior year can be based advantageously upon the social science program of the University of Chicago, a study "of economic, political and social institutions in the perspective of the industrial revolution." It would be a much more abbreviated affair than the work of the two syllabi published, probably by the most fragmentary of in-

clusions from the second year course which considers three special social problems; the basic material of the first year is all possible of retention with less full treatment than is possible at Chicago with its more generous time allotment.

For senior year a study of United States political and governmental methods should be made. Future citizens should know these matters. These United States grew through its first century urged on always by what James Truslow Adams calls the American dream, a democratic state with safety and prosperity for all who exercised the cardinal virtues of industry, intelligence and thrift. That dream is dim indeed today. We have forgotten the faith of our fathers and many who are organized to perpetuate that dream are prominent by ignorance of its spirit. Lincoln's vision that a state cannot endure half slave and half free still is true. The fate of the American democratic state depends upon citizens who know its form and content of spirit. Our engineering students should emerge from our doors competent citizens with the spirit of our founders and an understanding of modern scientific social knowledge.

The University of Chicago syllabi in the humanities and social science are a magnificent gathering together of essential knowledge for one who would understand the modern scene. No other compendium on so comprehensive a base and so definitely aimed at social comprehension is available. Whatever courses are inserted in our technical program with this same purpose must take careful cognizance of these syllabi. They furnish a definite suggestion to any who realize that their aim for underclassmen at Chicago must be our aim for all engineering students as well. It is a simple matter to place these twelve or fifteen credit hours of humanistic study in our engineering curricula—and when it is done there is ensured to the engineering student a wider view of man's world than now generally offered—and without this wide view man remains without understanding of his environment, a victim where he should dominate.

Discussion

J. K. Finch (Columbia University): I have been much interested in the forceful presentation of the problem of the place of the so-called humanities in engineering by Professor Sutherland and in the equally compelling challenge of Professor Gould for more active participation by the engineer in the solution of our modern social and economic problems.

Columbia has probably had a longer experience in working toward the ideal expressed in these papers than any other school. Almost twenty years ago—in 1914, to be exact—the standards of

our engineering schools were raised so as to require three years of pre-engineering training in Columbia College, or some other liberal arts college, for admission to engineering. Since that time it has been found possible to reduce this pre-engineering training to two years for well prepared applicants.

We went into this venture in higher education for the purpose of providing these truly professional elements, a more liberal training and a broader social and economic outlook, for the engineer. We knew we were ahead of the times. The fact that Professors Sutherland and Gould have been pleading today for a wider adoption of these same standards shows clearly that we were at least twenty, probably twenty-five, years ahead of the times.

This being the case, it is reasonable to suppose that, from this pioneer experience, we at Columbia should be able to offer some sound advice as to how the aims and ideals brought forward by Professors Gould and Sutherland may be effectively incorporated in an engineering curriculum. Two suggestions came to mind, the one general, and the other applying specifically to civil engineering.

The Columbia plan has been criticized on the grounds that our students are exposed for two or three years to the humanities and are then clapped into our engineering schools where they promptly forget about them. Indeed, Professor Sutherland has advocated another plan, namely that of spreading the cultural contact throughout the engineering course—making it concurrent with the strictly engineering subjects. Here we are faced with the difficulty that the student will almost invariably neglect such subjects in order to concentrate on his perhaps more difficult and frequently more interesting (at least from his viewpoint) engineering work. In my opinion, which one of these two schemes is adopted is immaterial. The problem cannot be completely solved by offering a few liberal courses.

Professor Sutherland is doomed to disappointment if he expects to make a liberally trained, "cultured" man of broad sympathies and interest out of the engineering student by simply exposing him to a few such subjects as our "Contemporary Civilization" or the Chicago program which he outlined. A few such basic courses are essential but the problem can only be solved by insisting that each engineering instructor shall not neglect, in presenting his subject, its cultural, social and economic implications. You cannot in general encourage and develop in engineering students interests and viewpoints more liberal and broader than those of the instructors with whom they have their most intimate and constant contacts.

Turning now to our experience in economics:

The economic side of engineering has been through two stages

of development. It began with the Greeks who appear to have been the first to introduce effectively the notion of economy. Indeed, the word was coined by the ancient Greek who spoke of his household effects as the ecos and who referred to the wise and thrifty management of these effects, including the very difficult matter of wife and children, as economy. Examples of economy in planning, of well considered efforts to reduce the expenditure of labor and materials to the minimum consistent with safe design, are evident in the work of the early Greek engineer. The tunnel drainage planned for Lake Copias about 300 B.C., for example, shows the use of a curved alignment evidently planned to reduce the total of tunneling and shaft sinking to a minimum. The Romans and later workers gave due attention to this subject. Today the technique of economic design is well developed and by means of graphs and other methods the engineer can quickly secure the most economical proportions for bridge spans, truss and girder depths, etc. This is the problem which some writers refer to as that of "immediate economy." The engineer has it well in hand and it is purely and strictly a technical matter.

In 1879, Arthur M. Wellington crystallized in his monumental work, The Economic Theory of Railway Location, the thoughts of engineers on the second phase of the subject, the problem of engineering works as investments. Wellington enunciated briefly, almost brutally, as the basic principle of a more general engineering economy, that the construction of an engineering work was not justified unless it could be shown that the investment of funds in the enterprise would be profitable. He was speaking for the individual owner. He did not consider the general social and economic values involved. His viewpoint is that of almost every engineer who has tackled the problem, and it has been the basic viewpoint in the development of our modern engineering world. Even the latest work on engineering economics, Grant's excellent "Principles," begins with a chapter on "Will it pay?"

Wellington's work sets down many basic elements in the technique of this type of economic analysis. It has been added to and developed to a high degree. There is still room for a difference of opinion on such questions as depreciation and the basic principles of valuation, but the technique of such analysis is constantly advancing and we can generally answer in dollars and cents, "Will it pay?"

Professor Gould has argued eloquently for a broader, a third stage, in the evolution of the engineering viewpoint in economics.

We can give the engineering student courses in economic theory and principles, we can require him to study social science and political trends, as has been suggested today, but we will never ac-

complish anything of real value unless we bring these ideas down to earth and think of the subject in the concrete, definite, mathematical terms which are characteristic of the engineering mind and are basic to the engineering method. This leads me to my second suggestion—a specific one, applying to civil engineering.

Can we broaden Wellington's principle of engineering economy to make it include the sound elements of public as well as private investment? Can we agree to write: "The construction of an engineering work is not justified unless the value of the *benefits* to be derived from such construction is greater than the cost of doing without it." This, it seems to me, is a broad enough principle to meet our needs. We must, of course, take a broad view of benefits, considering all possible present and future values both social and economic. Let us then develop for the analysis of these benefits, methods and a technique worthy of the problem involved. In short, let us tackle the problem in a truly engineering manner.

It is shocking to realize that we have on every hand costly works, designed for the public good, previous to the construction of which no attempt was made to analyze possible benefits. The New York State Barge Canal, an excellent piece of technical design, is one of the greatest engineering failures in the history of the world. You will hunt in vain for any real attempt, prior to construction, to compare the tax burden of its $170,000,000 with the benefits to be derived from its construction. Within the last few years the Port of New York Authority has built three great bridges between the mainland and Staten Island. To put it mildly, their estimates of benefits were, as our students say, all wet.

On the other hand, we have a few notable contributions and examples of what is engineeringly possible in this direction. The Miami Conservancy District appraisals of benefits—77,000 parcels appraised by the Miami engineers and only 500 cases appealed to the Conservancy Court. The recent report of the State Water Policy Commission of New Jersey on the Control of Floods in the Passaic Valley. These are milestones in the development of a broader economic analysis and important contributions to the technique of such analysis.

Engineers have developed to a high degree of perfection the technique of structural and machine design. They can predict with reasonable accuracy whether a work built for private owners will or will not pay. But the technique and analysis of this broader problem, of analyzing benefits of a general social as well as economic character, has been almost totally neglected. Many potential workers have been discouraged by the very apparent difficulties of the problem. These, however, are no greater than those which the engineer faced a century ago, in the field of structures

and mechanics. A technique can be developed and, by doing it, the engineer will bring to the analysis of these broader, larger problems the calm, deliberate, unemotional type of thinking on which his other professional abilities are based. In this way, and in this way only, may economic theory be brought down to the brass tack language which the engineer understands, and his social and economic viewpoint and interest be effectively broadened.

O. W. Eschbach (American Telephone and Telegraph Company): The question of how to introduce cultural influences and economic thinking into a curriculum essentially scientific in foundation has been alive for many years. It is being widely discussed today because the fallacy of too narrow an education, or too rigid an objective in training people for definite occupations has been emphasized by industrial conditions confronting us. The result will be that all of us will think more soundly in terms of related educational tools applicable to a variety of occupations or possible careers.

While an educational institution certainly is the most effective place to lay a firm foundation or to acquire useful basic knowledge, it is not the only place. A great deal of the seriousness of this discussion and what may appear to be urgent need for change in curricula is removed when you look upon a person's whole life as a matter of cumulative development and his educational experience as one of a series of concentrated efforts to acquire understanding of a veriety of both related and unrelated facts.

I have never felt that a person need go to college to acquire culture nor do I believe it is absolutely essential that he acquire an understanding of economic laws at this early period of his life. I do think, however, that both college and student miss the objective of advanced education if graduates do not have their imagination stimulated through contact with great literature and they are not instilled with the desire to know something of the background of the human race, something about the economic worth of the profession to which they aspire, and an appreciation of idealism in the use to which money and wealth may be put. If in addition to adequate technical training you can sensitize students so that they have an awareness of their responsibility in building a well rounded and useful experience in life, I think you will have laid the foundation of a scheme of education which they may follow through on their own initiative.

I have often felt that it was unfortunate that undergraduate instruction in engineering was so departmentalized. I do not suppose much can be done to break tradition and also recognize elements of impracticability in doing so. After all the majority of our engineering graduates never will be professional engineers in

the sense of practitioners in specialized fields and would be better off if individual courses of instruction could be arranged for them by competent teachers, with the aim of giving them a better understanding of related fields of science.

It is fine to see here the recognition of our social responsibility to develop the kind of education most effective in giving those graduates the opportunity to grasp things as they come. I hope that whatever changes are made will be made in the light of better understanding and with the more permanent values of education constantly in mind.

A. F. Hamdi, Philadelphia: About two months ago in Philadelphia, a man at a certain meeting of unemployed engineers called for leaders. In this group of engineers there were graduates of last year, and men who had been out working for the last fifteen or twenty years. About twenty of this group answered the call and went to see this man who was looking for leaders. Except for two, all asked this question: Now that I am here, what do I do? Instead of wanting to lead, they were ready to be led. The other two were ready to lead, and said so.

A second case was brought to my attention by a man who had attended a dinner where two men spoke. The first man to speak was an engineer: he knew his subject from A to Z; and had an excellent paper—typed on seven or eight sheets of paper. He mumbled on his piece for about 45 minutes and put half of his audience almost to sleep. The next speaker was a salesman: he knew nothing about matters technical, he had nothing in particular to say, but he knew how to talk. He woke up the sleepy audience, caught their interest, and made them laugh. After he got through, the audience was no wiser, but had listened to some good stories, and possibly remembered them the next day—whereas the engineer's highly technical and valuable discourse was almost a total loss!

What is the answer? To my mind, there is only one answer: let us raise the professional standing of the engineer to that of the lawyer and the medical man. Most of us know the term "quack." Some of the younger men may not know this term, because most of the quacks have passed away, and new ones are not permitted to develop—the doctors have taken care of that! They require, not only a college education before permitting a man to enter a medical school or a law school, but the graduate has to pass additional examinations before he is permitted to practise his profession.

My boy wants to become a medical man. He was told that unless he can graduate from college in the upper ten per cent of his class, he will have a mighty slim chance of being admitted into a medical school. That is what engineering schools should do. Engi-

neering schools have been turning out engineers too much on the wholesale basis. Furthermore, as Professor Finch once said, boys go into engineering because they can take apart the kitchen clock and put it together again. That seems to be true, but it certainly is a mighty poor criterion for selecting an engineering career for a boy.

Professor Finch referred to the six-year engineering courses in Columbia. I feel very strongly upon this subject, and would like to see our engineering schools not only insist upon a college education, but go beyond that; not permit a college graduate to enter the engineering school, unless he is a fit subject for such education. It is my belief that by the time a young man gets his college degree, the college psychologists can certainly determine if he is likely to develop into a successful engineer. It is of course possible that such rigid selection may prevent some likely youngsters from obtaining an engineering training, but in the long run, I believe the method I have outlined is sound, and it is a good way in which the present situation can be corrected.

NOTE: Since this was written two new courses have been made available to engineering students at Lehigh University beginning in 1935, and will be required by several of the course curricula. From the descriptions it is evident that they endeavor to accomplish the purpose outlined in this paper.

Business 51. SOCIAL INSTITUTIONS. A one-semester course outlining the fundamental institutions of the social order, with special reference to the origin, growth and present interrelations.

Government 60. INTERNATIONAL POLITICS. In this course the following topics among others are considered: state systems of the ancient world, the emergence and evolution of the European state system and its transferal to the western hemisphere, capitalism and the states, nationalism and the states, international disputes and their settlement, war in world society, the politics of peace. Throughout this course the influence of scientific advance and especially of technology upon competing state systems is emphasized.

Among other texts being considered for use in these courses are

INTERNATIONAL POLITICS—Schumann, McGraw-Hill Book Co.

INTRODUCTION TO WESTERN CIVILIZATION—Hedger, Doubleday, Doran & Co.

EFFECT OF THE PRESENT ECONOMIC DISLOCATION ON OUR CO-OPERATIVE PROGRAM*

By GEORGE W. BURNS

University of Cincinnati

In discussing the effect of the present economic dislocation on our co-operative program, it will be well to keep in mind the magnitude of this economic dislocation and the nature of the conditions under which we have been called to operate during the past four years. When the stockmarket crash came in November, 1929, to be followed later by increasing unemployment, we felt that it was another of those cyclical depressions which have the unhappy faculty of visiting us every seven or eight years. We were not particularly alarmed, because we had weathered other depressions before.

The co-operative course in Cincinnati was started in 1906. It was therefore only about a year old when the money panic of 1907 struck it. We can also recall the hard times of 1914, and the crash of 1921–22; but the co-op course was able to withstand the onslaught of all these trying periods. Not only was the course able to stand up in these depressions, but we had been through floods, strikes, and other labor difficulties which had paralyzed temporarily a large number of the co-operating firms. In addition, the system had proved itself equal to the demands of a war emergency. When the United States entered the World War, we abandoned the co-operative plan at the request of the Government, so that all of our students who were physically qualified could enter the Student Army Training Corps. Just as soon as the World War was over, the University resumed co-operation almost over night. Our policy had always been to build up and maintain co-operative relations with a large number of diversified industries, both for variety of experience and for security of employment. Therefore, when the upheaval of 1929 occurred, we were not particularly worried; we simply tightened our belt, snapped our jaws together, and worked hard to keep the course running smoothly.

Our unemployment for 1929 and the first part of 1930 was negligible, but the last of 1930 was not so good. Still our unemployment was not serious. In 1931, business got off with a nice

* Presented at the Conference on Co-operative Work, 40th Anniversary Meeting, S. P. E. E., June 26–30, 1933, Chicago, Ill.

start, people were optimistic, it looked as if the worst of the depression were over. The cheerful statements of the President of the United States seemed to lend justification to this optimism, but our joy was shortlived. The revival of employment which was noticed in the late winter and the spring of 1931 proved but a flash in the pan. Rumblings and ominous sounds were heard everywhere. Pessimism had taken the place of optimism. Then came the German Moratorium and the ensuing revelations of a demoralized condition in international credit and exchange. Unemployment increased alarmingly, business failures were numerous, and closing of banks was one of the chief news items in our papers.

By the summer of 1931 we were fully aware that it was not the usual cyclical depression with which we were battling. Our Faculty got together and organized a schedule of cultural subjects which were offered to students who found themselves without a job. The schedule included such subjects as Astronomy, Botany, Economics, Geology, American Political History, Political Science, Architectural History, Landscape Architecture, Philosophy, and Psychology.

Most of these cultural subjects were given in the mornings. In the afternoons, instructors were provided to aid students to improve their drafting and lettering. These courses were given for the most part by the head professors of each of these fields. Now we all know the criticism which is directed at the ordinary engineering curriculum. It has been charged that the average engineering schedule is narrow and contains too many technical subjects and not nearly sufficient cultural subjects. Well, this gave us an opportunity to inject a good dose of cultural subjects into our engineering program. Attendance at these lectures was not required, nor was academic credit given. Students were expected to submit every week a collection of brief notes on each of the lectures they had attended. That our unemployed students got a vast amount of good out of these lectures was evidenced by the character of the reports they turned in. In this connection it should be borne in mind that the class of students who attended these lectures was a transient group composed of men who were on short-time schedules or were temporarily out of a job. At times there were as many as seventy-five in attendance and then, within a day or two, this number might drop down to thirty or forty. This, of course, depended upon employment conditions. I remember that at one time there was hardly anyone in the classroom and the professor wondered where his class was, until we told him that we had sent out thirty students to the Globe-Wernicke Company.

For those students who wished to obtain academic credit, a plan was devised whereby they could submit a report on collateral read-

ing in any field of knowledge and on any body of subject matter suggested by the lectures. As a first step toward obtaining such credit, the student was required to submit a proposed program of reading, together with a bibliography. After these were approved, he could gradually assemble notes and a report to cover the range of his reading. It was required that this report be submitted one week before the end of the semester. The above program was put into operation for the year 1931–32. It was hoped that sometime during the year business conditions would improve, and that such a program would be unnecessary despite the obvious educational values of these cultural courses. But such was not the case. As you all know, instead of getting better, business got much worse. The darkest year our course ever had to operate under was 1932, especially up to September 1 of that year. Business and bank failures became so numerous that newspapers were afraid to publish them. You all know the mob spirit which prevailed in our agricultural regions. Some of our best insurance companies were caught in the debacle.

Despite our very best efforts, we constantly lost ground in the year 1932. By dint of hard labor we were able to land a job or two, only to learn upon returning to the office that perhaps half a dozen students had been laid off that day. So realizing that conditions were getting considerably worse instead of better, the Coordination Department recommended to the Faculty that the courses in the various departments of Engineering, Commerce, and Applied Arts be so organized that our unemployed students could go to school full-time and thus be able to graduate in four years instead of five. While this entailed an enormous amount of work in every department, nevertheless, the whole Faculty tackled the job in a fine spirit, and early in 1932 we notified all of our students that if we could not find work for them they would be permitted to attend school full-time and thus shorten their course by one year. Perhaps the most gratifying fact during this depression of unprecedented severity was the fine esprit de corps of our student body. At no time during the entire history of the course at Cincinnati has the morale of the students been better or the academic work so satisfactory. The depression seemed to sober our students and make them more serious, and this has been reflected time and again in the academic work. Our losses among students above the first year have been considerably lower than usual. Only in the enrollment of our freshmen have our numbers been below normal. Roughly, in 1929 and early in 1930, about ten per cent of our cooperative students were out of work; from June 1 until 1931, about twenty-five per cent; and from May until September, 1932, about thirty-five per cent. September, 1932, was the turning point in

our employment situation. From September 1, 1932, until January 1, 1933, our employment situation was stationary; if anything, we made some slight gains. The bank holiday in March, 1933, temporarily halted the steady gains in employment we had been making since the first of the year. For the past month business has picked up in brisk fashion, and we have been able to place more men than in any period since 1929.

It might be of interest to note how the various departments of our school have been affected by the depression. Chemical Engineering has been affected less than any other department. We have always been able to keep about seventy-five per cent of our Chemical Engineering students at work. Civil Engineering and Applied Arts have been most adversely affected. It has been a hard job to keep fifty per cent of these boys at work. Aeronautical and Mechanical Engineering have been next to Chemical Engineering students in being able to weather the storm of the depression. Electrical Engineering and Commercial Engineering have fared slightly worse than Mechanical Engineering. The women in our co-operative course in Commerce, due in part to the small numbers and part to the unusual ability of the Co-ordinator, have been employed almost one hundred per cent. Our most difficult job has been to secure employment for our freshmen who have had no industrial experience. While so many married men with families have been out of work, it has been difficult to place these young inexperienced freshmen. In this connection may I say that when an employer raised the married-men issue against the placing of inexperienced freshmen, the University always backed down. We used no high-pressure tactics to get our students jobs at the expense of married men with families. We felt that this was the wise policy to pursue, having in mind the welfare of the co-operative course over a long period of time.

Our co-operative employers retained the services of our upperclass co-ops in surprisingly large numbers. The wisdom of spreading the employment of co-ops among a large number of employers has proved itself over and over again in this depression. From a security of employment standpoint, telephone companies, gas and electric companies, various departments of local muncipalities, state highway departments, United States District Engineers' offices, manufacturers of consumers goods, insurance companies, and chain grocery stores have proved to be the best place for co-ops to be employed during the depression.

To revert again to the economic situation, perhaps it should be pointed out that there has been a tendency to blame the engineer for many of our economic ills and misfortunes. You all have heard the criticism directed against engineers and technologists be-

cause of the so-called "technological" unemployment resulting from the use of automatic machinery. Indeed, college presidents, social scientists, welfare directors, and men high in government offices have stated that, in their opinion, for the next decade or more the best minds among our young people should be directed away from engineering and toward the social sciences. The implication has been that the engineers have built a huge Frankenstein which has got out of control and has been running amuck and tearing our civilization into shreds. And yet, it is the engineer and the scientist who have removed the heavy burdens of physical labor from the backs of men, and who by orderly development have made possible our bridges, dams, skyscrapers, automobiles, locomotives, and automatic machinery. When you realize that in the United States to-day we have enough capacity in factories and farms to give the whole nation a very plentiful life with all of us working six hours a day, five days a week on the average, and when you further realize that our farms are glutted with products, our factories are shut down, and people have not enough to eat and are not properly housed and clothed, and that this is because there has not been enough research on equitable distribution along the lines of ordinary fair play, it seems hardly fair to place the blame on the engineer. The distribution end is the economist's job and to some extent the job of the political scientist. The difficulty with our experts in distribution and finance is that they do not have the material tools, and the mathematically exact formulas to work with that the engineer has and so the progress has lagged in comparison. However, the present tangled condition of affairs is a part of the readjustment out of which a distribution scheme must and will be worked.

History records many periods of great upheaval which have led to a new day in mankind's thought and life, a rebirth of a new order. The best thinkers tell us that we are going through the labor pains of such a rebirth now. The saying that history repeats itself is true, for after each one of these rebirths we have come into a better day. If the lessons of history mean anything at all, they mean that we are coming into a better day now which will make our present disturbed condition seem as dark and gloomy to the next generation as the older primitive civilization seems to us; and in this new dawning, engineers trained in the practice as well as the theory of engineering will play an important part.

PUBLIC SPEAKING AND THE PURSUIT OF CULTURE *

By BALDWIN M. WOODS

Professor of Mechanical Engineering, University of California

For several years past the engineer has had more than his usual share of attention. He has been blamed for over-production, the machine age, and unemployment. On the other hand, he is accused of taking too small a part in the administration of society. In one place Stuart Chase, a friendly critic, writes as follows: "I speak of the engineering mind. This is not to be confused, alas, with the average engineer as we know him. At the beck and call of the business man, the poor fellow can hardly be said to have a mind. He is narrow, near-sighted, over-specialized, even as is his master. He has no more sense of state than a rabbit. But before he was yoked to the treadmill, there were moments when he glimpsed the dignity, the responsibility, the supreme challenge of his profession; when, for a lucid interval, he realized that he belonged to the most important profession in the modern world; that indeed he had the world in his keeping."

Most critics agree that from the nature of his work the engineer is honest. Except for dissenters, usually in the ranks of his own profession, he is supposed to obtain efficiency. But it is generally agreed that he is uncultured.

This asserted lack of culture is often discussed by the alumni. Frequently they propose remedies. A course or two in literature, a few in history, a taste of political science and economics, and we are told that the culture index will rise thirty points! Is it possible that these remedies are, as Mary Pickford says, like "repainting the pump to improve the well water?"

To some of the older teachers, the training provided by the college of engineering added to the native ability and background of the student has produced some cultured engineers. These teachers find several points of merit in the engineering curriculum as it exists. In the first place, the curriculum is coherent. One is able to see the reason for inclusion of the courses in it. It is also progressive in difficulty. Further, the applied science courses of the third and fourth years frequently do succeed in imbuing students with the scientific spirit. Finally, the young engineer at

* Presented at Pacific Southwest Section, S. P. E. E., University of Southern California, December 28, 1933.

graduation is disposed to believe wholeheartedly that engineering is intended to apply the natural forces for the benefit of mankind. In other words, he is an idealist.

The older teacher also seems apprehensive when radical changes in the curriculum are proposed. He asks, "Which of the basic courses in the sciences are to be eliminated to make way for the so-called cultural courses?" A little questioning brings from him the comment that progress in natural and applied science is so rapid, and the engineering applications so numerous that there is danger of disintegration of the present curriculum, if large subtractions are made. He will suggest, instead, wise use by wide-awake students of available electives.

Again, one is led to inquire whether culture is to be obtained like credit for courses, at so many units per semester. One of the wisest teachers of English that I ever knew once remarked that the greatest aid to culture he could think of was to be born into the right kind of a family. The teacher of engineering, if he begins to hope that training in social sciences will bring culture, is somewhat discouraged when professors of English, history, political science, economics and sociology confess that their own students seem to be lacking in this important evidence of enlightenment.

I have purposely refrained up to this point from a critical examination of the term *culture*. It would be serious, however, to modify curricula to attain culture without first deciding, to some degree of exactness, what this elusive quality is and how it is to be obtained. One definition states that "culture is the enlightenment and discipline acquired by mental and moral training." This indicates that it may be measured by both attitude of mind and state of knowledge. Another thoughtful man writes: "Culture is a growing consciousness of the universe." The emphasis in this definition is clearly upon the attitude of mind achieved. John Cowper Powys in "The Meaning of Culture" says: "The cultured man is the man whose interior consciousness is forever obstinately writing down every chance-aspect of every new day that he is lucky enough to live to behold." He continues: "This achievement is of course a matter of habit. But it is a habit well within the scope of every son or daughter of Adam. To attain it one must be epicurean in one's power of lively response to the simplest recurrent sensation."

Summing up, we may say that culture is evidently an attitude of mind or a personal philosophy which makes one conscious of the many-sided world in which he lives. Ordinarily, one does not increase his culture as much by continued study of his profession as he does by acquiring knowledge of other professions. It is on this account that well-conducted courses in literature, history, eco-

nomics and the social sciences are a great aid. For the prospective Latin teacher it is unlikely that additional courses in Latin could be called cultural; likewise for the student in engineering, additional courses in the theory of structures, in thermodynamics, in electronics, are professional rather than cultural in their effect.

Consideration of the emphasis placed by most writers and thinkers on the attitude of mind which characterizes the cultivated man led some of us to ask ourselves the following questions. First: Who, if not the engineering teacher, should be most interested in contributing to a broad and tolerant understanding of civilization on the part of the undergraduate student of engineering? Second: If the most important thing to be attained is an attitude of mind rather than a body of knowledge, isn't it possible that a single course would contribute materially to the desired result? Third: If a course is to be devoted to this purpose, and to be taught by engineering professors, what is the simplest means of assuring progress of each student? Fourth: If public speaking be made the means of instruction will it be flexible enough to permit accomplishments in other directions, frequently suggested by practising engineers and alumni?

These queries led some of us to organize a course for seniors eight or ten years ago. We did not start out to provide, except indirectly, a cultural stimulus, even though we recognized the need.

Just after the World War our problem was presented with the influx of large numbers of students. The curricula in mechanical and electrical engineering still required a thesis of every candidate for the bachelor's degree. With the growth of a senior class to one hundred or more students, and with the corresponding increase in teaching load all along the line, it became apparent that supervision of theses could be only perfunctory. Only students with a certain kind of initiative would benefit from the requirement. However, we were convinced of the desirability of having every student attack some problem of his own, and of having him ascertain from available sources what progress had been made in the problem or the type of problem which he selected. After much discussion it was decided first, that the students having definite and appropriate thesis subjects in mind, and having a good scholarship record, should be permitted to undertake thesis work as in the past. In the second place, that all others should be enrolled in a course in which each would have the opportunity to review the progress in some fields of engineering through the study of current technical literature and the presentation before the class of the results of his review. It was expected that with classes of about twenty students, several members could present their reviews at each class period, and so each would have opportunity to investi-

gate a number of lines of progress during the semester and to report upon them. I believe that the new plan was approved and the instructors assigned to their sections of this course before any one fully realized what a problem both the students and the instructors had on their hands.

For the first few months each instructor kept hoping that his students would learn to present their material in an intelligible fashion. Stage fright, lack of organizing ability, ignorance of outlining methods and limited vocabulary, threatened to wreck the course. Furthermore, at every turn, the instructor was impressed with the lack of comprehension on the part of the student of the significance of the material which he had to present. About this time also, an alumni committee recommended that the College of Engineering establish compulsory training in English and public speaking. So, to save a bad situation, we modified the course both in intent and in method. Perhaps I can give you the best impression of what it now is by describing a typical class meeting. Organization differs in different sections of the course. The meeting here described is one of a section which has been extremely successful during the fall semester of 1933–34. I quote from the notes handed to the class by the instructor.

"The following plan of conduct will be adopted during the current semester, in this section.

"Each class period will be presided over by a student chairman whose chief duty will be to conduct the meeting in accordance with parliamentary procedure. He will also act as time-keeper and will rigorously enforce the time schedule.

"A student will be designated each day to act as *secretary*. His duties will be to record all transactions of the day in concise form and at the next following class meeting, at the call of the chairman, first to call the roll and then to read the minutes of the preceding meeting. The minutes are to be prepared so that they may be read in the allotted time, and they must be given to the instructor at the close of the period.

"Following the reading and approval of the minutes, the Chairman will call for Committee Reports in accordance with the Order of the Day. Each day there will be a report from the Committee on Current Events, two Special Committees, the Committee on Speech Improvement, and the Committee on Resolutions. Immediately following each special committee report the chairman will call on the appointed discussor to criticize the report as to presentation and content.

"The purpose of the Committee on Resolutions is to place some motion before the group. The motion, when seconded, is then open for discussion. Students are expected to discuss the motion extemporaneously. In other words, the motion that is to be made should remain unknown to all save the originator. The chairman of the meeting can recognize any one who wishes to speak for a period not exceeding two minutes. The whole pur-

pose is to give opportunity for extemporaneous speaking and for practice in parliamentary procedure.

"Each special committee report, carefully written, is to be handed to the instructor at the close of the period."

It is clear that, in this organization, committees simulating those in large public and private organizations serve as a framework for the course. The part played by each student and the significance of the committees become clearer upon examining the time schedule of the meetings, as follows:

10:10–14 Call to order; roll call; secretary's report.
10:14–17 Report of Committee on Current Events.
10:17–30 First Special Committee Report.
10:30–32 Discussor on Special Report.
10:32–45 Second Special Committee Report.
10:45–47 Discussor on Special Report.
10:47–52 Committee on Speech Improvement.
10:52–59 Committee on Resolutions.
10:59–60 Onnouncements by Instructor.
11:00 Adjournment.

It is clear that a fair percentage of the students in each section will participate in every meeting. This will normally contribute to enthusiasm for the course. It is also clear that the chairman must be exacting in adhering to the schedule or the speakers who have prepared to present certain parts of the program will not have opportunity to do so.

Attention is now invited to the special committees mentioned above. For the current semester in the class mentioned, the committees are: Education, Business, Foreign Affairs, Transportation, Law, Banking, Government, Science, Naval Affairs, Engineering, Culture. Each student is appointed a member of several of these special committees, usually the ones which he elects. He is expected to furnish one or more topics for discussion or consideration by each of the special committees of which he is a member. In due time, representing the committee, he will make one of the special committee reports, mentioned in the time schedule, utilizing the allotted thirteen minutes for the purpose.

It is not feasible in a short paper to describe the work of each of these committees, the purpose for which the committee exists, and the methods employed. It is apparent, however, that this artifice simulates the later work of the engineer in committees, on boards of directors, and before public bodies, where he is called upon to report on a project and to advocate action. It is also clear that the variety in the committees will insure consideration of many topics of broad interest, while within each committee there will be reasonable unity of purpose in the subjects considered.

It would be unfair, however, to leave the subject of committee organization without more specific reference to the Committee on Resolutions. The member of this committee, reporting on a given day, may make any formal motion which he desires. It is then seconded and discussed under parliamentary procedure. Interest in the motion and in discussing it of course depends in considerable measure on the wisdom of the committee in choosing the motion. It is discovered in practice that the need for parliamentary procedure is soon apparent to all members of the class. They therefore became accustomed to conforming to parliamentary procedure and the successive chairmen become acquainted with this procedure. As may well be imagined, the motions submitted cover many subjects of student and public interest. A fair sample is: "Mr. Chairman, I move that this class endorse the money policy of the President of the United States." It is quite interesting to learn that the motion proposed on the final day of the course called for endorsement by the class of this proposition: "This is the most successful course taken by any of us in the University." It was unanimously adopted.

It is difficult to separate the purposes of the course from its achievements. From the beginning, each instructor has had his own methods and has modified procedure in his efforts to get results. At a recent conference of instructors of the course there was general agreement that the following are important objectives:

1. *Increased ability to listen.*—The student is made aware of his inability to listen by the simple expedient of having one member of the class read a page from the writings of some clear thinker and expositor. At the conclusion each is asked to write down a résumé of what was read. The results are astonishing to those who are not acquainted with the experiment.

2. *Facility in preparing a paper.*—This includes ability to find references, to abstract them, to make an outline, and throughout to use efficiently the aids afforded by the library. The engineer of today who does not examine the work done by others before undertaking investigations of his own, is at a serious disadvantage. On the other hand, one who studies his problems through the minds of others, as revealed in articles, monographs and books, has almost unlimited knowledge at his disposal.

3. *Experience in public speaking.*—All instructors agree, and students concur, in the belief that the experience gained in public speaking is the most valuable in the course. The present organization of college instruction gives students little opportunity to express themselves orally. They attend lectures, they prepare reports, they solve problems, they take quizzes and examinations, but they do not speak. The opportunity to do so is almost a novel

experience. It brings them into a new world of things. Through friendly but definite criticism by colleagues, the student is made aware of his deficiencies in speaking technique and in subject matter. The instructor can do much to encourage a broad spirit of tolerance which will allow to each member of the class the freedom of thinking and concluding without exempting his opinion from criticism by others.

4. *The writing of reports*—The difficulty of English composition, including such simple matters as spelling and punctuation, is repeatedly apparent. The best results have been obtained through severe grading of the reports, preferably by readers from the English Department, in matters of spelling, punctuation, grammar, paragraphing, use of words, and organization of material. The reader is encouraged to make full criticisms and the student is asked to rewrite a report if a considerable number of comments have been made.

Nothing is more common to-day in the business world than the writing of reports. Engineering students have for years been more competent in this field than those in other colleges. Business men not in the field of engineering have often sought engineering graduates because of this special training. This course can be made a valuable supplement to other instruction in report writing. It is especially valuable for reports which differ materially from laboratory reports and problem sets.

5. *Development of student initiative.*—Generally speaking, the most successful sections of this course are those in which the students have not merely done most of the work but have done most of the planning. Contrary to popular belief, this does not mean that the instructor has an easy time. The more an instructor endeavors to have the class do, the greater is the burden which falls upon him. He must be free, out of class hours, to meet students singly or in small groups, to hear their ideas, to offer friendly suggestion and counsel, and to devise ways and means whereby results can be obtained. If the question is properly handled, there is no difficulty in developing interest on the part of the students. Interest in public questions comes promptly. Interest in engineering can be taken for granted. Interest in more subtle fields, such as art, literature, music, and philosophy comes with time and effort. The instructor is the mainspring of the course. If he is not interested, alert, self-critical, resourceful, patient, and industrious, interest will lag, achievement diminish, and the value of the course will become secondary to that of courses in the social sciences.

We have often been asked why the course should not come earlier than the senior year. Possibly it could be given to ad-

vantage earlier in the curriculum. There is one important psychological reason for its present position. A freshman or a sophomore in an engineering college is primarily interested in studying engineering subjects. He does not wish to be led aside from his major purpose, and, in our judgment, he should not be. It is probably in the junior or senior year that he becomes conscious of the fact that his college course will not include all of the subjects which he believes that the educated man should have studied. This thought comes to him first as a suspicion and later as a conviction. By the time he is a senior, he is ready for help in gaining admission to fields of knowledge other than those of his own choosing. There is therefore no sales resistance, so to speak, to be overcome. From the time the student with quivering knees, parched throat and perspiring brow delivers his first report until he acquires in fair degree self-control, ability to think on his feet, and fair speaking technique, he is convinced of the importance of what he is doing. He is determined to get his share of the benefit of the experience.

It should not be inferred from the foregoing that a high degree of culture is obtained by every student who follows this interesting course. It is probable, however, that few go through the experiences there involved without a broadening of interest and an increase in power. The growth of the spirit of tolerance and fair play is one of the most noticeable characteristics of the men. As the end of the senior year approaches and graduation is imminent, the student faces one of the great transitions of his life. No one who has experienced the change from undergraduate life to the experiences which follow can easily forget the lost feeling which follows Commencement. It is our hope that the habits acquired in this course will then assert themselves, at least to a certain degree, to help the student in placing himself in the world. It will not matter if twenty or forty years are acquired for the attainment of enlightenment and discipline and a cultivated mind. Even nations make slow progress toward these qualities. It is vital, however, that the direction taken by the individual shall be toward enlightenment and tolerance and not toward ignorance and despotism.

NEW MEMBERS

ARM, DAVID L., Assistant Professor of Mechanical Engineering, Lafayette College, Easton, Pa. Morland King, W. B. Plank.

CARSON, GORDON B., Instructor in Mechanical Engineering, Case School of Applied Science, Cleveland, Ohio. E. S. Ault, F. H. Vose.

CRENSHAW, JOHN B., Professor and Head, Department of Modern Languages, Georgia School of Technology, Atlanta, Ga. N. C. Ebaugh, A. D. Holland.

FAY, ALBERT H., Assistant Professor of Mining Engineering, Lafayette College, Easton, Pa. W. B. Plank, Morland King.

LANG, FRED C., Professor of Highway Engineering, University of Minnesota, Minneapolis, Minn. B. J. Robertson, O. M. Leland.

PATTISON, FLOYD, Professor of Mechanical Engineering, Kansas State College, Manhattan, Kansas. F. F. Frazier, C. H. Scholer.

TAPY, RALPH W., Instructor in Electrical Engineering, University of Detroit, Detroit, Mich. Clayton J. Pajot, C. J. Freund.

83 new members this year.

The T-SQUARE PAGE

DEVOTED TO THE INTERESTS OF THE DIVISION OF ENGINEERING DRAWING

FREDERIC G. HIGBEE, EDITOR

The Cornell Meeting: Members of the Engineering Drawing Division should plan to attend the annual meeting at Ithaca. In addition to a program of papers and discussions of more than usual interest, now in the process of formulation by Chairman H. M. McCully, a number of distinctive exhibits are to be held.

1. A collection of material showing the evolution and variety of instruments used in engineering drawing. Committee in charge: Frederick W. Ming, Chairman, Brooklyn Polytechnic Institute; C. E. Townsend, Cornell University.
2. A collection of old drawings showing the development of engineering drawing. Committee in charge: William G. Smith, Chairman, Northwestern University; S. J. Berard, Brown University; F. R. Finch, University of Michigan; Justus Rising, Purdue University; Richard S. Kirby, Yale University.
3. A collection of books, both ancient and modern, on the subjects of engineering drawing and descriptive geometry. Committee in charge: F. M. Porter, Chairman, University of Illinois; Steven Cleary, Cornell University; Justus Rising, Purdue University; Thomas E. French, Ohio State University.
4. An exhibit of student engineering drawings with awards to be made for the best three drawings in each of four classes. Committee in charge: Frederic G. Higbie, University of Iowa.

Members of the division, as well as the members of the Society, will have an unique opportunity to examine material of an historic nature and of considerable educational value which will be exhibited for the first time at this meeting.

The concern of the division, once such material as this has been collected, should be to arrange for a place where it can be suitably cared for and maintained as a permanent collection and exhibit. There are a number of museums which no doubt would not only be eager to secure this material but also to aid the division in adding to the collection from year to year.

COLLEGE NOTES

Carnegie Institute of Technology.—A graduate course in Photoelasticity to be given under the direction of Dr. Mac M. Frocht, associate professor of mechanics, will be offered during the 1934 summer session.

The course is planned primarily for teachers of mechanics, civil engineering, mechanical engineering, and related subjects. Dr. Frocht has developed a fine laboratory in connection with his research study in this field, and this will be available for student use.

A grant of $25,000 for the establishment of a research laboratory in experimental physics has been made by the Buhl Foundation of Pittsburgh. The new laboratory will be presided over by Professor Otto Stern, who will undertake further studies of the structure of the atom with the use of molecular beams, a method of investigation originated by him.

The **Case School of Applied Science** will inaugurate a night school beginning September, 1934, the first, strictly its own, since the founding of the institution.

For the past several years, Case and Western Reserve University have collaborated to offer evening courses under Cleveland College. Under the new plan, Case will maintain its own evening work entirely separate from the other institution. In their entirety the first two years of study will be presented in the evening classes and by the same faculty as in the day session. A student may graduate in two years of regular attendance after the completion of the first two years in the night sessions.

Many graduate courses in science and engineering will be offered for the benefit of the more mature and employed engineers and executives of the technical industries of Cleveland.

The same entrance requirements and the same high standard of scholarship will be exacted of the evening students as at present for those of the regular sessions.

University of Idaho.—Ivan C. Crawford, Dean of the College of Engineering, on leave of absence to act as State Engineer for the Committee on Federal Appropriations for Idaho was further appointed State Representative for U. S. Coast and Geodetic Survey in charge of organization and operations of field parties and office personnel.

University of Illinois.—In January, 1932, the College of Engineering undertook to establish the grade-point system for evaluating the quality of the scholastic work of its students. When it was first adopted, the system was applied only to students newly enrolled in the University; but at the beginning of this current school year, it was made effective for all students within the College.

For a number of years, the University has used the letter system, A, B, C, D, and E, for recording the grades of its students. As a prerequisite for graduation under its previous system, each student was required to have a grade of C or better in three-fourths of his accumulated credit-hours required for the degree in his curriculum. So far as graduation requirements were concerned, the system gave no added recognition to grades higher than C. Under this new plan, each student in the College must earn as many grade points as there are credit-hours in courses required and elective for graduation before he receives his degree.

Besides serving to establish the student's status for graduation, the plan also serves as one of the criteria for giving the student a rating or standing at the end of each semester; for if he does not earn a sufficient number of grade points during the semester, he may be automatically placed on probation or be dropped from the College. In this way the system begins to act as a check on the student's work early in his period of registration at the University.

The grade-point system gives increased recognition to high scholastic achievements, and discounts correspondingly all work of an unsatisfactory character. It is felt that the plan is more indicative of a student's real scholastic progress than the former practice of evaluating the upper passing grades of A, B, and C alike in determining the graduation, drop, or probation status of a student. The number of grade points in any course is determined by multiplying the credit-hours of the course by the proper grade-point index,—A = 3, B = 2, C = 1, and D and E = 0.

Another thing that may be of interest at this particular time is the fact that during the current school year, the College of Engineering has put into operation three new courses, elective for students in all departments within the College. Two of them, Industrial Relations and Engineering Economics, are open to students of junior standing, and the other, Engineering Law, is open to students of senior standing. Each one of these courses is taught by an engineering professor and each one is given for three hours credit.

Iowa State College.—Prof. Neil P. Bailey, associate professor of mechanical engineering at the University of North Carolina, has been appointed head and professor of the Mechanical Engi-

neering Department at Iowa State College. He is to replace Prof. Warren H. Meeker, who will retire as head of the Mechanical Engineering department this summer, but will continue as a full professor.

Professor Meeker is now in his forty-third year as a teacher of mechanical engineering—a period of service which ranks him as the oldest veteran among staff members of the Engineering Division at Iowa State College. He graduated from Cornell University in 1891, and in the same year came to Iowa State as assistant in mechanical Engineering. He was appointed assistant professor in 1900, professor of mechanical engineering and superintendent of heating, lighting and water service at the college in 1907, and head of the department in 1912.

BOOK REVIEWS

Electrical Engineering Laboratory Experiments. By C. W. RICKER AND C. E. TUCKER. McGraw-Hill Book Co., Inc. Third Edition. 403 pages. $2.75.

In the new edition the authors have divided the first part of the book into four chapters, namely: (1) Measuring Devices and Their Applications, (2) The Calculation of Instrument Ranges, (3) Suggestions for the Writing of Reports, (4) Safety Rules and Suggestions.

Compared to the last edition, Chapters one, two, and three have been revised and Chapter four is a new addition and a very good one. The above chapters cover 55 pages.

The remainder of the book consists of 68 experiments and an index. The experiments are divided as follows: 1 to 12 inclusive are electrical measurements; 13 to 15 inclusive are electronics; 16 to 34 inclusive are direct current machinery; 35 to 63 inclusive are alternating current circuits and machinery; 64 and 65 are rectifier study; 66 is on control; 67 and 68 are transmission line study. An index has been added to the new edition.

The authors have done a very good piece of work in the new edition.

P. E. RUSH.

Higher Mathematics for Engineers and Physicists. By I. S. AND E. S. SOKOLNIKOFF, Mathematics, University of Wisconsin. McGraw-Hill Book Co., Inc., 1934. Xiii + 482 pages. $4.00.

This book is "the substance of the orientation course of lectures offered . . . to students who have a knowledge of the elementery calculus." The keynote is "practical utility," giving "a bird's-eye view of those topics . . . indispensable in the study of physical sciences." "Each chapter is as nearly as possible an independent unit, in order to enhance availability for reference purposes." It will "serve as a stepping-stone to advanced mathematical treaties." The authors have fully accomplished their objectives as outlined in the preface from which the above quotations have been taken.

The fifteen chapter headings are: Eliptic Integrals, Solution of Equations, Determinants and Matrices, Infinite Series, Partial Dif-

ferentiation, Fouriers Series, Multiple Integrals, Line Integrals, Improper Integrals, Ordinary Differential Equations, Partial Differential Equations, Vector Analysis, Probability, Empirical Formulas and Curve Fitting, and Conformal Representation. There are approximately 400 well-chosen illustrative examples, solved and proposed for solution with answers.

K. D. SWARTZEL.

CONFERENCES PLANNED FOR CORNELL MEETING, JUNE 19–23, 1934

Electronics and Electrical Communications.
W. L. Everitt, Ohio State University, Chairman.

Use of Models in Laboratory Teaching of Structures and Hydraulics.
Fred L. Plummer, Case School of Applied Science, Chairman.

Mechanics of Fluids.
H. L. Mason, Columbia University, Chairman.

Unit Processes in Chemical Engineering.
Frank C. Vilbrandt, Iowa State College, Chairman.

Heat Transfer.
Frederick C. Stewart, Pennsylvania State College, Chairman.

Pre-College Guidance and the Orientation of Freshmen.
F. C. Dana, Iowa State College, Chairman.

Drawing Division.
H. M. McCully, Carnegie Institute of Technology, Chairman.

English.
Sada A. Harbarger, Ohio State University, Chairman.

Coöperative Division.
J. E. McDaniel, Georgia School of Technology, Chairman.

Machine Design Division.
Frank L. Eidmann, Columbia University, Chairman.

Mechanics Division.
A. E. Norton, Harvard University, Chairman.

Junior Colleges.
R. A. White, Grand Rapids Junior College, Chairman.

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